NAVAL ATLANTIC METEOROLOGY
AND OCEANOGRAPHY FACILITY

JACKSONVILLE, FLORIDA

# LOCAL-AREA FORECASTER'S HANDBOOK

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# SECTION I - BASIC DESCRIPTION

## A. Introduction

1. Forecasting for the Jacksonville area offers a challenge to the newcomer experienced in tropical forecasting as well as the forecaster familiar with mid-latitude forecasting techniques. Jacksonville is situated near the northern boundary of the tropics and, as a result, two distinct weather regimes prevail during separate periods of the year. In winter, the local area has a temperate climate with several long periods of overcast sky conditions, rain and drizzle, while summer brings the typical tropical climate with the normal thunderstorm activity, bright sunshine and uniform daily temperatures. High humidity exists throughout the year. Because of Jacksonville's southern location, numerical weather prediction products are less effective in this region than in a typically mid-latitude region. Jacksonville is too far north, however, to make use of the streamline analyses used in the tropics. Moreover, wintertime frontal systems push southward to Jacksonville and then stall as they come into contact with the warm waters of the Gulf of Mexico and the southern North Atlantic. These frontal systems then oscillate within the local area.

2. This edition of the Local Forecaster's Handbook for the Naval Atlantic Meteorology and Oceanography Facility, Jacksonville is written using climatological data for NAS Jacksonville for the period 1945-1992, as compiled in the International Station Meteorological Climate Summary distributed on CD-ROM by COMNAVMETOCCOM.

## B. Topography and Location/Exposure of METOC Assets.

1. NAS Jacksonville, Florida is located at Latitude 30°14'N and Longitude 81°41'W, near the northern boundary of

the Atlantic easterly trade winds. It is situated six miles south of downtown Jacksonville, on the west bank of the St. Johns River and 14 miles west of the Atlantic Ocean. The average field elevation is 22 feet above MSL. The surrounding terrain is swampy, interspersed with slightly higher sandy soil which is heavily wooded with pine trees. The southeastern edge of the Okefenokee Swamp, which is mostly marsh and shallow water, is located 38 miles northwest of the station, (see Figure 1). John Towers Field, the landing area at NAS Jacksonville (see Figure 2) is located on the northern side of NAS Jacksonville and consists of two paved asphalt active runways which are 200 feet wide. They are:

| | |
|---|---|
| 09-27 | 8,000 feet (main instrument runway) |
| 14-32 | 5,977 feet |
| 01-19 | inactive |
| 04-22 | inactive |

2. NAVLANTMETOCFAC Jacksonville is located in the Operations Building (Bldg. 118 - See "A" in Figure 3) except the Mobile Environmental Team, located in building 101F.

a. Building 118 Department locations are:

(1) Administration - Second floor, northern portion of East Wing.

(2) Operations - Second floor, western portion of North Wing. Refer to Figure 4 for configuration of the operations spaces.

(3) MESD - Meteorological Equipment Services Division, First floor, southern portion of East Wing.

b. MET - Mobile Environmental Team Building 101F, approximately 100 yards southwest of building 118.

## C. **Meteorological Equipment**

1. Meteorological equipment:

DESCRIPTION

Rain Gauge - ML-217 4-inch plastic rain gauge.

Aneroid Barometer - ML-448UM elevation 43.0 feet above MSL.

Marine Barograph - elevation of 42.0 feet above MSL.

Lightning Position and Tracking System (LPATS)

RADIDS Network Color Weather Radar* scheduled to be replaced by NEXRAD in Jan '95

GSIDS Satellite Processor/Looper

SMQ-11 Satellite Processor Receiver

SMQ-11 Satellite Antenna is located atop bldg. 118

TESS-3 Tactical Environmental Support System

AN/GMQ-29 Remote Sensor Site - The temperature
and dewpoint sensing elements and the tipping-bucket rain gauge

of the AN/GMQ-29 are located near the west end of the field, 600 feet from the centerline of inactive runway 04-22 and 950 feet north of the centerline of runway 09-27. The site, because of its proximity to the St. Johns River, causes humidity readings to be slightly higher with an easterly wind component, and in the winter temperatures appear non-representative (high) when the wind direction is between 000° and 090° (over-water flow). * Scheduled to be replaced by the

Automatic Surface Observation System (ASOS), spring '95

Aerovane - The UMQ-5C Aerovane is located 910 feet east of the `NAS Jacksonville TACAN and 737 feet north of the centerline of `runway 09-27 at the 6,000 Foot Mark.

Cloud Height Set - The AN/GMQ-13B Cloud Height set is located 750 feet north of the centerline of Runway 09-27 on the west end of the field with the detector located 400 feet due east of the projector.

Transmissometer - The AN/GMQ-32 Transmissometer is located 670 feet north of the centerline of Runway 09-27 about 400 feet from the west end of the runway. The receiver is located 500 feet from the projector on a bearing of 065°.

## D. Effects of Surrounding Terrain and Water Area on Local Weather

1. Due to the proximity of the Atlantic Ocean, 14 miles to the east, and the Gulf of Mexico within 100 miles to the southwest, the climate of NAS Jacksonville is largely controlled by marine influences. Jacksonville does experience effects of Polar outbreaks in winter, but the low terrain surrounding NAS Jacksonville does little to impede the passage of storms from any quadrant.

2. The Appalachian Mountain Range, lying about 400 miles northwest of the station, provides an important obstruction to

advancing fronts. This terrain often causes a distortion which may produce a developing vortex in the vicinity of Atlanta, Georgia that moves to the northeast and occasionally delays the passage of the trailing cold front at Jacksonville.

3. The St. Johns River, adjoining the Air Station, produces a moderating effect on temperatures. The slightest wind trajectory over the river can cause a 10-15° temperature change in winter. Northward moving air-mass thunderstorms have a tendency to follow the course of the St. Johns River.

## E. Weather Communications

| Service | Circuit |
|---|---|
| DIFAX | Satellite Feed |
| GSIDS | 52LFGS700172 |
| CONUS Meteorological Data System upgrade | Satellite Feed |
| LPATS | Satellite Feed |
| RADIDS | ATD97671 |
| TESS-3 | BWXD70RK (DDN link) |
| AUTODI | Naval Computer and Telecommunications Station (GATEGUARD) |
| Pilot to Meteorologist Service (PMSV) | 344.6 |
| NODDS/OPARS | Telephone modem link, Everex 3000R Computer |
| Hurricane Hotline Station 41 | 52LGGS707835 |

## F. Commands and Staffs Supported

1. The following units are supported by NAVLANTMETOCFAC Jacksonville:

Commander Naval Base Jacksonville

NAS Jacksonville (including tenant commands and transient aircraft)

Commander, Patrol Wing ELEVEN

Commander, Helicopter ASW Wing Atlantic

Naval Aviation Depot

Naval Air Reserve

7 VP squadrons, including VP-30 (RAG), and VP-62 (Reserve)

8 HS squadrons, including HS-1 (RAG), HS-3, HS-5, HS-7, HS-11,

HS-15 and HS-75 (Reserve)

VR-58

Commander, Submarine Squadron TEN

FACSFAC Jacksonville, FL

NUSC AUTEC, Andros Island

Air National Guard, Craig Field, Jacksonville, FL

SUBASE Kings Bay

NAVBASE Charleston

Naval Training Command Orlando

Naval Station Mayport (Sub-Regional Forecast Support)

Naval Air Station Key West (Sub-Regional Forecast Support)

Cudjoe Key TARS Facility (Sub-Regional Forecast Support)

Commander, Naval Base Charleston Sub Area's Alpha I,II

Commander Naval Base Jacksonville Sub Area Bravo

Air National Guard, Jacksonville IAP, Jacksonville, FL

Florida National Guard (Army), Camp Blanding FL

Grumman St Augustine Corporation, St Augustine, FL

2. Naval Atlantic Meteorology and Oceanography Facility Jacksonville provides, on a routine basis, the following Meteorological/Oceanographic (METOC) services to the commands and staffs supported:

Forecasts -

Daily printed 36 hour forecast

Terminal Aerodrome Forecasts (TAF)

Destructive weather forecasts

Submarine Transit Forecast

Charleston Naval Base Forecast

Kings Bay Submarine Base Forecast

Mayport Naval Station Forecast

Key West OPAREA Forecast

Tongue of the Ocean OPAREA Forecast

Freeze Warnings

Aviation Services -

Pilot briefings

Pilot to Meteorologist Service (PMSV)

Weathervision Data Display

Horizontal Weather Depictions (HWD)

Optimum Path Aircraft Routing System (OPARS)

Oceanographic / ASW -

Acoustic briefings and data packets

Special order acoustic products

Preparation and transmission of bathythermograph (BT) data

3. Naval Atlantic Meteorology and Oceanography Facility Jacksonville also provides, on a request basis, tailored METOC services including: climatological studies, seasonal weather briefings, and predeployment/exercise briefings. Additionally, the forecaster at the Facility may have occasion to prepare the following special METOC products:

Drift Calculations

Radiological Fallout

"D" Values

Radar Propagation

Surf Forecast

Sound Focusing

Drop Zone Forecast

Integrated Refractive Effects Prediction System (IREPS) products

# SECTION II - CLIMATOLOGY

## A. <u>Types of Weather Systems Affecting Jacksonville</u>

1. The California Institute of Technology weather system types are represented by a typical sequence of broad scale features of pressure distribution. In this typing system, the broad features of the upper westerlies are recognized as the steering mechanisms for migratory cyclones and anticyclones. There is a tendency at times, for the jet stream to shift to the south over a broad sector. This southward shift in the steering current causes a corresponding southerly shift of the migratory cyclone paths.

2. In Figures 5 through 8 the mean upper level flow in the core of the westerlies is indicated by dashed lines with arrows. The trajectories of major polar outbreaks, which occur during the life of each type are denoted by double arrows. Successive daily positions of a single cyclone and its associated frontal system as it advances through the southeastern states, are shown in conventional fashion.

3. It is characteristic in the eastern United States that a system moving out of the eastern zone may leave behind a trailing front in the Gulf of Mexico. This frontal zone lingers until the next system type moves in. As the frontal trough of the next type moves eastward, the divergence aloft often causes cyclogenesis on the Gulf front. The Gulf Wave then moves northeastward affecting the weather farther east. There are two types of Gulf Waves denoted Ga and Gb.

4. The ideal Ga type is illustrated by Figure 5. It has the following characteristics:

a. An upper-level trough is located just west of the

Mississippi Valley with an upper-level ridge between 110°W and 130°W. The upper-level trough is usually progressive due to its short wave length.

b. A wave cyclone forms on a quasi-stationary front near the Texas Coast with the approach of a new frontal trough from the west.

c. This new low deepens and moves northeastward on a path just west of the Appalachians, accompanied by widespread precipitation to the north.

d. It is most frequently observed in winter and spring.

5. The ideal Gb type is illustrated by Figure 6. It has the following characteristics:

a. A sharp upper ridge is located near 100°W, with a trough along the east coast and another trough near or off the west coast.

b. A wave forms on a quasi-stationary front in the east Gulf due to the approach of another upper trough from the west.

c. The wave moves east-northeastward and, when in the vicinity of the southern Appalachians, new cyclogenesis occurs near Hatteras, NC.

d. The Hatteras low immediately becomes dominant, and advances rapidly northeastward along the coast, deepening quickly.

e. This type is most frequent in the winter.

6. In the spring and early summer, the cold waters of Hudson Bay tend to produce and maintain high pressure which may extend southward into the midwest and stagnate. Lows moving in from the west are pushed southward around the high. This type is called Ha. On other occasions the high, or a portion of it, moves almost due south along the east coast and appears to merge with the Bermuda High cell. This type is called Hb.

7. The ideal Ha type is illustrated by Figure 7. It has the following characteristics:

a. A slight ridge aloft is located near 75°W-100°W. A weak trough exists along or off the east coast with a weak trough in the vicinity of the west coast.

b. A persistent surface Hudson Bay High extends southward with a separate center over the Great Lakes.

c. Surface low movements are quite erratic but are deflected by the stationary high extending from Hudson Bay.

d. This type is most frequently observed in spring and late winter.

8. The ideal Hb type is illustrated by Figure 8. It has the following characteristics:

a. Anticyclonic circulation persists over most of the United States with a trough normally along the west coast.

b. The Bermuda High is quite strong and blocks frontal systems from invading the southeast. The southeastern United States remains hot and humid.

c. A quasi-stationary east-west front exists in the middle Atlantic states with cool, dry air to the north, a strong thermal gradient, and associated thunderstorms.

d. This is a late spring situation.

## B. Monthly Climatological Summaries and Storm Tracks

### 1. **January**

a. The highest frequency of Arctic and Polar outbreaks occur during January. These outbreaks often extend down to the southern portion of Florida. Jacksonville lies predominantly in a modified Continental Polar air mass during the winter months. The Polar Front, having reached its extreme southern limit, begins receding northward. Cyclogenesis occurs throughout the northern Gulf of Mexico and off the north Florida Atlantic coast. Four secondary storm tracks affect the local area during January, reflecting the active areas of cyclogenesis in the northern Gulf of Mexico. Three of the tracks are orientated generally SW-NE through southern Georgia and central Florida. The fourth track lies SSW-NNE about 150 miles east of Florida.

b. Rain is the predominant form of precipitation with occasional freezing rain and drizzle during the passage of wave cyclones. Some years a trace of snow may fall.

c. Mostly clear and cloudy skies occur with about equal frequency. Surface winds are predominantly northerly.

2. **February**

a. Throughout February the Polar Front continues its northward migration. However, cold frontal passages and invasions of modified Polar air are quite frequent. Cyclogenesis occurs more often than in the previous winter months due to the greater contrast in temperature between water and land. The secondary storm tracks remain essentially unchanged from January.

b. Rain is the predominant form of precipitation. The average measurable amount increases from January due to the more frequent passage of wave cyclones. Occasionally, a trace of snow will fall during February.

c. Surface winds continue to be northerly and show a slight increase in speed. There is less fog, better visibility, and higher ceilings than in January. There is not much change in total sky cover except possibly a few more clear periods. The main restrictions to visibility are divided equally between fog, smoke, and haze.

3. **March**

a. The Polar Front continues to drift northward and the mean position now lies through the northern Gulf states, North Carolina, and Virginia. Frontal passage over the local area occurs less frequently than in the previous months. The secondary storm tracks have now moved north and west of Florida and are positioned SW-NE through the western Gulf of Mexico and E-W through the northern portion of the gulf states and into Virginia. The track east of Florida has disappeared and the cyclogenetic area has shifted to the coastal area off Cape Hatteras.

b. Flight conditions improve this month. There is less fog, higher ceilings, and a lower frequency of precipitation and restrictions to visibility. The number of days with precipitation decreases along with the average measurable amount.

c. Surface winds shift to southerly with a slight increase in average speed. March is also the month with the lowest average relative humidity. Stratified rain continues as the predominant form of precipitation. A trace of snow may fall in extreme years. Smoke and haze are the main restrictions to visibility.

4. **April**

a. The transition from winter to summer begins this month. The Polar Front has moved to a position just south of the Great Lakes and although frontal passages are about as frequent as in March they are less intense. Many fronts become stationary just north of Jacksonville and many dissipate in this vicinity. The secondary storm tracks maintain their March positions. Cyclogenesis to the west of Jacksonville is almost absent and only on rare occasions will the local area be affected by a wave cyclone.

b. The sub-tropical high begins moving northward and ridging westward causing the prevailing surface winds to shift from the south to southeast. Also, the warming land mass gives rise to more frequent sea breeze conditions. Rainshowers occur slightly more often than continuous rain as the predominant form of precipitation.

5. **May**

a. The transition from winter to summer continues until mid-month. The Polar Front is well into Canada and the secondary storm tracks are located in the mid-Atlantic states.

b. The sub-tropical high is the dominant feature of the circulation and mostly clear skies prevail. NAS Jacksonville experiences the second lowest frequency of inclement weather for any month of the year.

c. Convective rainshowers are the predominant precipitation pattern. Thunderstorm activity increases sharply from the previous month with an average of seven days.

d. Surface winds prevail from the east-southeast and decrease in speed.

e. The main restrictions to visibility are smoke and haze.

6. **June**

a. The Polar Front remains in Canada and the secondary storm tracks persist in the mid-Atlantic states. Hurricane season begins!

b. The predominant air mass type is Maritime Tropical. The surface wind become southeasterly and continue to decrease in speed as the gradient becomes weaker and a more uniform pressure field prevails. Due to the increased solar insolation and dominance of Maritime Tropical air, the frequency of shower and thunderstorm activity and measurable amounts of precipitation increases.

c. Ceilings are slightly lower because of the increasing shower activity. The main restriction to visibility remains smoke and haze, but precipitation is a close second.

7. **July**

a. Summer is well entrenched. The local area is dominated by a flat ridge of the Azores-Bermuda High. Occasionally, a very weak cold front will pass.

b. South of the Azores-Bermuda High, trade winds flowing across the ocean gather moisture and attain a temperature equal to or greater than the warm water. This air arrives over Jacksonville with considerable thunderstorm potential. Climatology confirms that July has the most days with thunderstorms (16) due to the warm land and weak pressure gradient.

c. Due to the increased sea-breeze activity the surface wind is primarily from the southeast through south. The main restriction to visibility is showers and haze.

d. Easterly waves occasionally reach as far north as Jacksonville and troughing in the easterlies continues in the tropics and sub-tropics.

8. **August**

a. A weak, uniform pressure gradient continues this month as the Azores-Bermuda High continues to dominate the weather.

b. Easterly waves occasionally reach as far north as Jacksonville. Tropical storms are more frequent, and seriously threaten northern Florida. One storm track lies northwesterly across Andros Island, the Florida Keys and into southeastern Louisiana. Another track lies northwesterly on the windward side of the Bahamas, gradually recurving north to Cape Hatteras and then northeast into the Atlantic.

c. Sky cover amount and precipitation amount is slightly less than July. Thunderstorm activity decreases to 14 days.

9. **September**

a. The Azores-Bermuda High reaches its northern-most position during September. As a result, the prevailing surface winds shift to the northeast and increase in average speed.

b. One tropical storm track lies from the Gulf of Mexico northeastward across northern Florida, in the vicinity of Jacksonville, and on into the Atlantic. The second track lies SE-NW through the Yucatan Channel into the Gulf of Mexico.

c. Rain is the predominant form of precipitation, but showers occur almost as frequently. The average amount of precipitation is less than August, but days of occurrence are about the same. There is a marked decrease in thunderstorm activity as more stable air lies over Jacksonville.

10. **October**

a. Mid-October marks the beginning of the transition from summer to winter. The Polar Front begins its southward migration and frontal passages begin to occur. An occasional wave cyclone will form to the west of the local area and influence the weather at Jacksonville.

b. Tropical storm tracks are limited to a SW-NE orientation across southern Florida.

c. The average pressure is relatively high, with the center northwest of Jacksonville. Surface winds back to a more northerly direction and increase in average speed from the previous month.

d. Sky cover decreases although ceilings and visibilities are lower due to an increase in radiation fog.

e. Rain is the predominant form of precipitation, although showers and drizzle are not uncommon. Thunderstorms average two days.

11. **November**

a. The transition from summer to winter regime continues this month. The Polar Front lies through Virginia and southwestward into Texas. The secondary storm track lies off the east coast of Florida. NAS Jacksonville can expect an increase in cold frontal passages and some cyclogenesis in the Gulf of Mexico.

b. November is the month with the least amount of precipitation, and shares with April the least monthly average sky cover.

c. The prevailing winds are from the north and show a decrease in average speed.

d. The continued cooling of the land mass brings the average number of days with fog to fourteen.

e. Rain is the predominant form of precipitation. Occasionally drizzle will be observed. Showers seldom occur.

12. **December**

a. Winter is well entrenched by the middle of the month with frequent cold frontal passages, Gulf Wave cyclones, and cyclogenesis off Florida's east coast. Hurricane season ends!

b. The Polar Front is now displaced further south and lies SW-NE from New Orleans across the Gulf of Mexico to coastal Georgia. The Primary storm track lies from New Orleans northeastward through the southeastern United States. Another track enters Florida from the eastern Gulf of Mexico and extends northeastward to Cape Hatteras, where it joins the primary storm track. The third track lies off the east coast of Florida.

c. Prevailing winds are northerly with no change in speed from the previous month.

d. December experiences the highest number of fog days with seventeen.

e. Thunderstorms are very rare and generally occur with frontal passage.

## C. <u>Controlling Features of Synoptic Climatology</u>

1. Atlantic Ocean

a. Climatologically, the water surrounding the Florida Peninsula is an important influence on the local air temperature. In winter, cold air flowing over the Gulf Stream and the Florida Current (Figure 32) before reaching

Jacksonville causes temperatures in the local area to remain near or well above freezing while stations at the same latitude to the west experience temperatures that are 10°- 20° lower. In summer, the very high temperatures that might be expected for this latitude are seldom experienced due to the cooling effect of the adjacent water mass.

b. The extreme differential between land and water temperatures during the winter months accounts for the east coast being an area of frequent cyclogenesis.

c. The absolute lowest temperature on record is 09°F and the highest maximum temperature ever recorded is 102°F.

2. Gulf of Mexico. This body of water influences local weather when the flow is from a southwesterly direction. The Gulf, particularly the northern third, is an area of intense cyclogenesis during the winter months due to the land-sea temperature gradient.

3. Latitude. Jacksonville is situated close enough to the boundary of the tropics that two distinct weather regimes prevail. In winter the local area has a temperate climate while summers are tropical in character. This is due mainly to the location, movement, and intensity of the subtropical high pressure belt.

D. <u>Predominant Synoptic Patterns.</u> In figures 33 through 49, the dashed lines represent the 500 mb contours and the solid lines represent the surface pressure. Frontal types are of local designation and should not be confused with types in IAC code or other publications.

**D. <u>Winter Synoptic Climatology (Late November through March)</u>**

a. The Continental High (Figure 33): This is a polar air mass which moves southeastward from Canada into the United States and affects the local area much of the winter. This high usually follows two main tracks:

(1) Over the first track the high moves southeast to the Great Lakes Region and then swings eastward across Pennsylvania, New York, New Jersey and into the Atlantic. This one causes cold fronts to assume an east-west orientation and become stationary in the vicinity of Jacksonville.

(a) At Jacksonville, if the high follows the northern track, aviation weather will vary from IFR in stratus, drizzle, and fog, to ceilings greater than 10,000 feet with unrestricted visibility.

(b) When the front becomes stationary south of, or over the local area, the overrunning warm air, coupled with the east to northeast flow from the Gulf Stream, results in ceilings of 300-500 feet and visibility of 1-2 miles for several days.

(c) When the front becomes stationary to the north, only middle and high clouds will be experienced.

(2) Over the second track the high moves south/southeast to Texas before turning and moving east across the local area. The fast-moving cold front is usually associated with this type track.

(a) With the high moving eastward from Texas, post-frontal weather consists of mostly clear skies and unrestricted visibility. These conditions prevail until the high moves into the Atlantic and becomes greatly modified by its contact with the warm water. Haze and smoke layers form in this modified air mass and cloud conditions become scattered to broken at 3000-3500 feet with visibility 2-6 miles in haze and smoke in the on-shore flow, especially during the morning hours.

(b) In late winter gusty surface winds are frequently observed under this high due to a deepening wave cyclone near or northeast of Jacksonville.

b. The Subtropical High Pressure Ridge (Figure 34): The high pressure ridge results in an on-shore flow of Maritime Tropical air which occurs occasionally during the winter months. It is centered well out in the Atlantic with a ridge building westward into Florida. This synoptic situation usually follows a warm frontal passage.

(1) At Jacksonville, rapid improvement follows the warm front with only high scattered to broken cloudiness throughout the ridge.

(2) The surface visibility is unrestricted during the daylight hours, however it may be reduced in fog to 1/8-1/2 mile between midnight and 0600 local.

(3) Visibility begins to improve after 0600 local and is unrestricted again by 0830-1030 local.

(4) After a few days under this synoptic situation, the forecaster should be alert to abnormal diurnal pressure changes which cause gusty surface winds in the afternoon.

c. Fronts

(1) <u>Type 1 - Cold Front</u> - (Figures 35 and 36) With a Type 1 Front approaching Jacksonville, northwest winds

are found behind the front. This type front is generally a steadily moving frontal system that will give adverse weather for only a brief period, if at all. Aloft, the 500 mb trough extends from the north central United States southward to the Gulf of Mexico or southwestward to Texas. Normally, there is a strong ridge over the Pacific northwest and occasionally a weak ridge over the northeast. At the surface, a NW-SE oriented high moves southeast from the Pacific northwest and turns eastward when it reaches Texas. In the Atlantic, a high is moving rapidly eastward from the coast. Florida is under the influence of a flat ridge oriented between NE-SW and E-W. The best indication of this front approaching can be obtained from the surface map and hourly sequence reports to the west through north of the local area. A weaker gradient following the cold front may indicate slowing or stalling of the front or weakening.

(a) At Jacksonville, the front is preceded by southerly winds, increasing cumuliform cloudiness, and falling pressure.

(b) Altostratus forms at about 10,000 feet or higher, gradually lowering to 8,000 feet within 4 to 6 hours.

(c) Light rain may begin when the ceiling lowers to 4,000-6,000 feet.

(d) Normally, marginal VFR ceilings will occur about 3 to 5 hours after the rain begins and continue marginal until the front passes.

(e) If no rain is associated with the system, ceilings will remain 4,000 feet or better. Visibility in rain will be 4 to 6 miles.

(f) Immediately after frontal passage, ceilings will improve to 4,000 feet or better and visibility improves to 10 miles or better within 2 to 4 hours. Skies will normally be clear 6 to 8 hours after frontal passage.

(g) Frequently, the following high may change its orientation, and bulge into the Atlantic, north of Jacksonville. In this case surface winds become northeasterly several hours after the frontal passage. If this occurs within 24 hours, ceilings and visibilities usually become zero in fog at night, improving to scattered clouds at 4,000 feet and visibility 2-4 miles in haze and smoke by late morning and VFR by noon.

(2) Type 2 - Cold Front - (Figure 37): This frontal type is similar to Type 1 except that a squall line is found 50 to 200 miles ahead of the cold front. Sometimes this squall line will be depicted as a cold front aloft and then dropped to the surface as the front progresses. Indications of Type 2 cold fronts approaching the local area can best be found on the surface map and hourly sequence reports. As the squall line comes within a 120 mile radius of the local area, it can be observed on weather radar and tracked with considerable accuracy.

(a) At Jacksonville, the most severe weather is usually found in the squall line. The following cold front may contain lighter shower activity or possibly a wind shift with no precipitation at all.

(b) Normally, ceilings will be broken from 1,500-3,000 feet with a broken to overcast layer at 8,000 feet several hours prior to the arrival of the squall line.

(c) Surface winds will be light, southerly or south-southwesterly.

(d) With the approach and passage of the squall line, ceilings lower rapidly to 500-800 feet, visibilities are reduced to 1-3 miles in rainshowers, thunderstorms, and evaporation fog, and possibly drizzle.

(e) To the rear of the squall line ceilings improve slightly to 1000-1500 feet with scattered stratus at 400-800 feet. Visibilities improve to 7 miles and the surface winds become light and variable or light westerly.

(f) Scattered light showers may or may not occur with the frontal passage and the clearing that takes place is similar to that which occurs with the Type 1 front.

(g) Frontal passage can best be determined by a dew-point decrease.

(3) <u>Type 3 - Cold Front</u> - (Figures 38 and 39): In this situation, the cold continental high swings to the east in the north-central United States rather than continuing southeast to Texas, before turning east. This is the key in detecting a Type 3 cold front a day or two in advance of its arrival at Jacksonville.

(a) Normally, a flat E-W ridge on the surface lies over Florida. As the cold high begins turning eastward through Pennsylvania and New Jersey, the front will assume a more E-W orientation.

(b) This type of front creates unique forecasting problems when it slows down in the local area. It may move south of the station as a cold front and then return a few days later as a warm front; or it may become stationary in the vicinity of Jacksonville with inclement weather being caused by minor waves forming and moving along the front.

(c) At Jacksonville, sky conditions are similar to Type 1 cold front in advance of this frontal system, however, ceilings continue to lower to 200-500 feet by the time the front arrives in the local area. The northeast flow over the warm off-shore water will cause low stratus, drizzle and fog to persist for a long period.

(d) If the front continues moving south as a cold front, the weather will break by the time the front reaches southern Florida. If it moves back north as a warm front, the low stratus, drizzle, and fog will persist until the system is well north of the station.

(e) The front may become stationary in the vicinity of the local area and gradually dissipate causing IFR conditions in the Jacksonville area for 1 to 6 days and occasionally longer.

(4) <u>Type 4 - Warm Front</u> - (Figure 40): This system develops southwest of Jacksonville. Significant warm frontogenesis along the Gulf Coast is unusual. In most situations the advance of tropical air over the Gulf states is in a broad transition zone, without benefit of a warm front.

(a) The great majority of Gulf coast warm fronts are the "return cold front" type, rather than pure frontogenesis. These fronts usually move northward 2 or 3 days after a cold front has passed the local area. The weakening cold front will be reinforced with the addition of tropical air in the warm sector a short distance off-shore in the Gulf of Mexico. The approach of a low pressure system in the Oklahoma-Texas area causes the front to move northward. Normally, there is a long wave trough just east of the Rockies. A strong surface high is over Virginia and North Carolina with ridging north and south.

(b) At Jacksonville, poor flying conditions will prevail along the middle Gulf area with fog, stratus, drizzle, and light rain occasionally extending as far east as Jacksonville.

(c) The first indications of the approach of this type front is broken to overcast altostratus at 10,000 feet or above, gradually lowering to 6,000-8,000 feet within 5 hours.

(d) The precipitation will normally begin when the ceiling reaches 6,000 feet. The cloud decks then continue to lower to 800-1200 feet until the frontal zone is close. Then, they become 200-400 feet with visibilities less than 1 mile in drizzle, light rain, and fog.

(e) As the front passes, clouds dissipate in 2 to 4 hours and the sky condition becomes high scattered. Visibilities become 10 miles or better.

(5) <u>Type 5 - Fronts that threaten but do not pass</u>, or that eventually pass in a modified form: One of the greatest concerns to local forecasters is the front that never arrives, or that does arrive, but much modified. These usually start out as cold fronts and become stationary or quasi-stationary in the southeastern United States.

(a) An important indication that the front is slowing is a retrograding trough at 500 mb. As this trough moves westward the upper ridge normally continues moving eastward. In this case the front becomes quasi-stationary. It will remain stationary until the long wave trough begins progressing eastward again or another one forms after the original one has filled. There must be some upper wind vector perpendicular to the front if the front is going to move. (See east coast wedge front Page III-15.)

(b) At Jacksonville, if the system becomes stationary to the north of the local area, only scattered to broken middle clouds with unrestricted visibilities will be experienced. Visibilities will be reduced during the morning hours to 1-3 miles in ground fog, haze and smoke which dissipate by late morning.

(c) If the system becomes stationary over or just south of the local area, ceilings will be 400-800 feet and visibilities 1-3 miles in drizzle and fog, but occasionally reduced to zero to 200 feet and less than 1 mile. Ceilings and visibilities will remain low until the front begins to dissipate or move further south.

(6) Type 6 - Gulf Wave (Figures 41 and 42): A Gulf Wave forming along a weakened cold front or stationary front may be very difficult to detect. A close analysis of the upper air charts, especially the 500 mb level, will disclose short waves moving through the upper levels which will trigger the wave formation when they come in close proximity to the surface front. In addition to short waves, a cut-off low aloft (that frequently exists over the southwestern United States) may move eastward to the Gulf and cause a wave cyclone to form rapidly.

(a) Most of these waves follow a northeasterly course with the 500 mb wind prognosis. An objective technique for cyclone movement is presented later in this handbook.

(b) At Jacksonville, when the apex of the wave passes just north of the local area we may experience the complete range of frontal weather, both warm and cold, in rapid succession.

(c) The poorest local flying weather will usually be found when the wave center passes near or just south of the local area. When a wave passes well to the north, only scattered occasionally broken low, middle, and high clouds will be observed with the warm front. As the cold front approaches, ceilings become 1500-4000 feet with occasional shower activity. Low clouds will dissipate when the wave moves well to the northeast.

(d) When the wave center passes near or south of Jacksonville, pre-frontal cloudiness is observed with ceilings gradually lowering to 300-500 feet and visibilities 1-3 miles in light rain and fog. As the center passes south and winds shift to a northerly component, the ceilings lift to 500-1000 feet, the rain ceases and visibilities become greater than 7 miles. When winds become northwest and the low is well to the northeast, low clouds will dissipate.

(e) Occasionally, a wave will form and become stationary in the Gulf for 24 hours or longer. In this case ceilings will lower to IFR conditions very slowly as the precipitation gradually progresses northeastward. After the precipitation has arrived in the local area, IFR conditions will persist until the low begins to move and passes out of the local area or dissipates in the Gulf.

(7) <u>Type 7 - Atlantic Wave developing southeast of Jacksonville (Figure 43)</u>: A few times each winter waves will form along the polar front after it has passed Jacksonville and becomes quasi-stationary off-shore to the east or southeast. The wave must pass close to the station to significantly influence local weather. As with waves forming in the Gulf, close attention to upper contours and short wave movement will usually provide advance warning of the formation

of a surface wave.

(a) At Jacksonville, weather reaching the local area will be pre-warm frontal involving no actual frontal passage. Since these waves normally move in a northeasterly direction, the main precipitation pattern may remain off-shore.

(b) When the local area is well within the cyclonic circulation, however, ceilings will be 500-800 feet and visibilities 1 to 3 miles in rain and fog as the low approaches from the south. Conditions will improve to 1500-2500 foot ceilings and 8 miles or better visibilities shortly after the low passes to the east. The low cloud layers will usually break when the low passes to the east of the Cape Hatteras area or if the low is 7° or more to the east of Jacksonville.

d. Unusual Situations

(1) <u>Texas low moves eastward and passes close to Jacksonville:</u> Lows forming in the Texas area normally move northeastward and remain well to the north of the local area. Occasionally, they may move due east and pass close to Jacksonville before swinging northeast.

(a) A strong zonal flow exists aloft with a cut-off low in the southwestern portion of the country.

(b) A very strong ridge extending from the Gulf of Mexico to Canada acts as a block to any northeast movement and causes the cut-off low to move eastward.

(c) The cut-off low and its associated surface low then move toward the local area.

(d) The weather at Jacksonville will be similar to Gulf wave weather.

(2) <u>Texas Low moves northeastward in normal track and then suddenly swings southeast over Jacksonville:</u> This is a modification of the previous situation. Again, the triggering mechanism in this situation is the cut-off low aloft.

(a) It begins a normal northeastward movement.

(b) However, due to an intensifying ridge to the east, a blocking pattern is set up which causes the upper low and its associated surface cyclone to change course to the southeast around the southern periphery of the block.

(c) As with the previous situation, accurate prognosis of the 500 mb chart is the prime factor in detecting this situation.

(d) A forecaster can be caught unaware as this situation can occur quite suddenly.

(e) The weather at Jacksonville will be similar to Gulf wave weather.

(3) <u>Secondary front or troughing to the rear of the Polar Front:</u> This situation may occur when a Gulf wave forms and moves rapidly northeastward while occluding. A new polar front outbreak is pushing rapidly southeastward from Canada so that the local area may experience two frontal passages within a 24 hour period.

(a) A similar condition occurs when troughing exists to the rear of the polar front. It develops when a short wave aloft moves into an extremely deep long wave associated with the polar front.

(b) With the secondary front the weather conditions between fronts will normally have ceilings 1000-1500 feet and visibilities 4-6 miles in light rain and fog.

(c) At the secondary front, ceilings and visibilities are briefly 500-1000 feet and 2-4 miles, improving rapidly after passage.

(d) Some secondary fronts may give only 3000 foot ceilings and intermittent light rain.

(e) When troughing occurs to the rear of the polar front, usually scattered to broken middle and high clouds are observed.

(4) Temporarily stalled cold front: Due to the blocking effect of the Appalachians, some frontal passages can be delayed up to several hours at Jacksonville. Often a trough forms ahead of the blocked front. If the front is temporarily blocked by the mountains and then moves into the trough that has formed ahead of it, the front will pass the local area with little or no weather at approximately the same time it would have passed had the blocking effect not occurred.

## E. Spring Synoptic Climatology (April to mid-May)

The mean position of the polar front has begun returning to the north. In early April the sub-tropical high approaches from the southeast. The strong contrast between the two air masses produces considerably more thunderstorm activity than during the previous winter months. By the middle of May the warm sub-tropical high is the dominant feature and transition from winter to summer is complete.

a. The Continental High: In the spring this high does not penetrate as far south as frequently as is the case of winter (Figure 33). The main track carries the high southeastward from Canada under the 500 mb flow then eastward across Illinois, Kentucky, and West Virginia. If the polar air penetrates as far south as Texas, it follows the same track as in winter.

(1) At Jacksonville, with the high on an eastward track from Texas, weather conditions are similar to winter. Clear to scattered high clouds with unrestricted visibility will prevail following frontal passage until the high moves off-shore and becomes modified or until overrunning from the southwest causes a mid and/or a high ceiling layer to develop.

(2) As the high moves offshore, the air mass over land is modified by the onshore flow and cumuliform clouds develop.

(a) The visibility will be unrestricted until the lower 3000-5000 feet of the air mass is modified, usually by the second or third day of onshore flow. The lowest layers become moist and coupled with the subsidence inversion acting as a lid, industrial smoke and salt haze in the layer combine to restrict in-flight visibilities to 2-4 miles and surface visibilities to 4-6 miles.

(b) Frequently, ground fog will restrict visibility to 1/4 to 1/2 mile between 0600 and 0800 local in this modified air mass.

(3) When the high is on a northern track, fronts usually become stationary over or north of Jacksonville.

(a) If the front moves a short distance south, conditions will be broken to overcast middle clouds at 12000 feet or higher with scattered to broken lower layers near 3000 feet.

(b) Visibility will be 5-6 miles in haze and smoke.

(c) Occasionally, the middle layer becomes overcast and intermittent light rain will fall.

(d) When the frontal system dissipates conditions become high scattered and visibility improves.

b. The Subtropical High Pressure Ridge: By the middle of April the subtropical high has moved north of Jacksonville and the south to east flow moves the ridge further north and west.

(1) At Jacksonville, during early spring, scattered diurnal cumulus will form during the late morning at 3000-4000 feet and dissipate by 1800 local time.

(2) Later in April, the cumulus forms by mid-morning at 2500-3000 feet and occasionally becomes broken in the afternoon.

(a) Tops may be as high as 12000 feet.

(b) Scattered light rain showers may occur in the afternoon although this is more predominant in May.

(c) The cumulus becomes scattered by 1800 local time and broken middle clouds form above 10000 feet at this time.

(d) The mid clouds dissipate and skies become high scattered by 2200 local time.

(e) The visibility is unrestricted for the most part, except between the hours of 0500 and 0900 local time when ground fog, haze and smoke may restrict visibility to 4-6 miles.

c. Fronts: The major difference between spring and winter fronts is that the former have gustier surface winds. This is attributable to two situations: The associated low is deepening, and/or the frontal trough is particularly deep. Pre-frontal winds are normally south-southwest 20-25 knots with gusts to 30 knots or higher. The peak gust is observed at the frontal passage and may be 15 to 20 knots higher than the pre-frontal gusts. If the winds are related to the frontal trough they will abate about 3 hours after frontal passage. If they are due to intensification of the associated low, higher wind gusts will persist until the low ceases to deepen or moves well away.

(1). <u>Type 1 - Cold Front approaching Jacksonville with a westerly wind component behind the front:</u> The synoptic features are similar to the winter months (Figure 35) but not as pronounced. This system will occur occasionally during the spring, mainly in April. Many times the front will arrive as a Type 1 front, but due to the sudden recurvature of the continental high, it will assume an east-west orientation and become stationary in the vicinity of Jacksonville, moving north as a warm front the following day.

(a) On the few occasions when the front pushes south of the station as a normal Type 1 cold front, pre-frontal conditions will consist of scattered to broken mid and broken high clouds. Just prior to the arrival of the front, low clouds will form and become scattered to broken near 2500 feet and scattered showers and thundershowers will develop. Immediately after frontal passage the sky will become scattered at 12,000 feet with high, thin scattered above. Conditions will be high scattered or clear within 4 to 6 hours after frontal passage.

(b) If the front becomes stationary over or near Jacksonville and assumes an east-west orientation, scattered to broken low clouds at 2500 to 3000 feet, with broken to overcast layers above 10,000 feet and visibilities reduced in haze and smoke to 5 to 6 miles will prevail. If the front waves, intermittent light rain may fall. When the front dissipates, skies become high scattered and visibilities unrestricted.

(c) If the front becomes stationary to the north, skies will be scattered to broken at 8000 to 10000 feet, with a high broken layer above. Scattered to broken low clouds will form during the day at 3000-4000 feet and dissipate at night. As the front moves north or dissipates, clear and 7 miles will be the rule.

(2) <u>Type 2 - Cold front preceded by a squall line approaching Jacksonville:</u> Similar to Type 1 (Figure 37) except that the associated low is usually on a more easterly or southerly track than with a Type 1 situation. A frequent occurrence is for a Type 1 or Type 3 front to pass the local area, returning north as a warm front the following day, followed by a Type 2 cold frontal system on the third day.

(a) At Jacksonville, in advance of the

squall line, scattered cumulus at 3500 to 4000 feet with a high broken layer will appear when the squall line is in central Georgia.

(b) As the line nears, scattered to broken low cloud decks will form between 600 to 4000 feet with broken to overcast middle clouds at 8000 to 10000 feet with a high broken to overcast layer above.

(c) Surface winds become quite gusty as showers and thunderstorms occur.

(d) With the passage of the squall line, scattered low clouds at 2500-3000 feet and broken middle and overcast high clouds are generally the rule.

(e) Intermittent light rain may occur as the cold front approaches and passes.

(f) Clearing will take place within 4 to 6 hours following the cold frontal passage.

(3) <u>Type 3 - Cold front approaching Jacksonville with an easterly wind component behind the front:</u> This front (Figure 38) becomes quasi-stationary in the vicinity of Jacksonville. The position is directly related to the direction and speed of movement of the continental high, and the strength and position of the subtropical high.

(a) At Jacksonville, when the front becomes stationary to the north of the local area, afternoon conditions will be scattered to broken high clouds with visibility restricted to 4 to 6 miles in smoke and haze.

(b) Evening conditions consist of low stratus at 800 to 1200 feet overcast and visibility 3 to 5 miles in ground fog, smoke, and haze.

(c) After midnight, ceilings will gradually lower to 200 to 400 feet and visibility will be reduced to 1/4 to 1/2 miles.

(d) By 1000 local time the following day, ceilings are broken at 1500 feet and visibility improves to 4-6 miles.

(e) By noon the stratus is gone but visibility remains 4 to 6 miles.

(f) When the system becomes stationary to the south of Jacksonville, conditions are similar to a Type 1 cold front becoming stationary over or near Jacksonville.

(4) Type 4 - Warm Front developing southwest of Jacksonville: This is similar to the winter situation (Figure 40) except that it occurs more frequently. This front forms and moves back over the local area 1 day after a cold frontal passage, rather than 2 or 3 days as in a winter situation.

(a) At Jacksonville, as the warm front forms and moves northward, the middle layers become broken and the high clouds become overcast.

(b) Just prior to frontal passage a low cloud deck moves in at 1500-2000 feet and the middle layer becomes overcast at 8000 feet. Light rain, scattered showers and thunderstorms reduce the visibility to less than 4 miles until the front passes, when conditions become scattered at 10000 feet or above.

d. Unusual Situations

(1) Spring Special occluded front (Figures 44 and 45): Occluded frontal passages are rare in this area. However, there is one situation which brings the local area quite severe weather. A cold front extending from a low in the western Texas-Oklahoma area (associated with a closed low aloft) moves eastward and picks up the trailing end of a warm or stationary front in the western Gulf and becomes occluded. The parent low deepens into a major storm and moves slowly while the fronts move rapidly eastward. When the point of occlusion moves over the Gulf, a new low forms and begins to deepen. The low separates from the occlusion and moves northeastward with the occlusion trailing.

(a) At Jacksonville, an indication of the approach of this system is an overcast cirrostratus layer. Middle cloud layers begin forming as the warm front reaches southern Florida and stratocumulus decks form as the warm front reaches central Florida, at which time light rain begins.

(b) After about 4 hours of precipitation, ceilings lower to 400-800 feet and the visibility lowers to 1 to 3 miles.

(c) About 8 hours before the occlusion arrives, thunderstorms with hail and strong gusty surface winds commence and continue until just before the occlusion passes. Following the frontal passage gradual clearing takes place.

(2) Gulf Waves: These waves are extremely rare during the spring. When a gulf wave does form, it usually develops over the Louisiana coast in association with a cut-off low aloft and follows an eastward course toward north Florida.

(a) At Jacksonville, weather is similar to the winter situation except that ceilings and visibilities are slightly higher and not as much precipitation is experienced.

(3) Atlantic Waves: They are not as frequent as in winter. The main cyclogenesis area shifts to the east or northeast of Jacksonville. Due to the smaller contrast in temperature between land and water, these systems do not deepen as rapidly as in the winter.

(a) At Jacksonville, as the system forms to the east, ceilings in the local area will usually be 1200 to 1500 feet and rising as the system moves toward the northeast. If the system is close to land or is stationary, conditions in the local area will be 400-800 foot ceilings and good visibility during the day but lowering at night to 200-400 feet and 1/2 to 1 1/2 miles in drizzle and fog.

## F. Summer Synoptic Climatology (Mid-May through Mid-October)

a. The Continental High: The summer continental highs follow a west to east track across the midwestern states and pass offshore in the vicinity of the New Jersey coast. The track and the small size of the summer high cells result in cold fronts traveling only as far south as the area between Charleston, SC and Savannah, GA. Occasionally, a front will become stationary as far south as central Florida. Very rarely will the high push far enough south, or be intense enough to push a Type 1 cold front past Jacksonville.

(1) When they do, skies will be clear to high scattered at night, with scattered stratocumulus and cumulus forming at 3000 to 4000 feet between 0900 and 1100 local. These clouds occasionally become broken in the afternoon and will dissipate by 1800 local.

(2) Visibilities at the surface are generally unrestricted during the day, but reduced to 4-6 miles in ground fog, haze and smoke between midnight and 0900 local. In-flight visibility is reduced in haze during the daylight hours.

(3) This system brings temporary relief from the heat of the Atlantic ridge (Bermuda high).

b. The Subtropical High Pressure Ridge: This system dominates the summer weather at Jacksonville with the highest frequency of occurrence in July. Three distinct situations are evident in summer:

(1) In the first and most frequent, the ridge is very well developed to the south. Usually a front will be in the vicinity of the Carolinas causing a slight cyclonic curvature of the isobars in the local area (Figure 46).

(a) This pattern will cause scattered altocumulus and cirrus during the period from midnight to 1000 local.

(b) Occasionally, if the southwesterly flow is strong enough, scattered to broken stratus at 500 to 1000 feet will drift over the station from the Gulf of Mexico after 0300 local and dissipate between 0600 and 0900 local.

(c) Visibility will generally remain unrestricted during this period, however in later summer visibility may be reduced to 3-6 miles in ground fog, haze, and smoke between 0500 and 0700 local.

(d) Scattered cumulus will form between 0900 and 1000 local with bases at 2000 to 3000 feet becoming broken by 1300 local and have tops above 20000 feet by 1530 local.

(e) Scattered showers will occur in the period 1300 to 2100 local.

(f) This situation often produces prolonged and severe thunderstorm activity. Gusty winds of 40 or 50 knots are not uncommon.

(g) Low clouds will become scattered at the end of the shower and thunderstorm activity (2100-2300 local) and dissipate within 2 to 5 hours, leaving broken altocumulus above 10,000 feet and broken cirrus. These clouds then become scattered during the early morning and the pattern is repeated as long as the ridge remains south of the area.

(2) The second pattern has a well developed ridge line over or just north of Jacksonville. Weak anticyclonic curvature is present at the surface (Figure 47).

(a) This pattern causes scattered altocumulus and cirrus and occasionally clear skies during the early morning hours. Scattered cumulus form between 0800 and 1000 local with bases near 2500-3000 feet and become variable scattered to broken in the afternoon.

(b) Isolated showers and thundershowers will be in the vicinity between 1500 and 2000 local. The thunderstorms are mild and seldom have gusts in excess of 25 knots.

(c) Ceilings and visibility with the thunderstorms will generally be VFR. The low clouds dissipate during late evening, leaving scattered middle and high clouds which occasionally dissipate during the early morning hours.

(d) Visibility outside of the showers and thundershowers is normally unrestricted, however, late in the summer visibility may be restricted in ground fog and haze between 0500 and 0800 local.

(e) The light and variable winds aloft resulting from the weak anticyclonic curvature produces nocturnal thunderstorms over the adjacent ocean area that occasionally move inland between 0900 and 1000 local. These thunderstorms are milder than the daytime version.

(f) Low ceilings are rare and gusty winds are nearly nonexistent.

(3) In the third, the ridge is centered in the vicinity of Charleston, SC. Marked anticyclonic curvature is evident on analysis for the local area (Figure 48).

(a) This pattern causes clear to scattered middle and high conditions. Scattered cumulus form at 2000 to 3000 feet between 0800 and 1000 local, becoming broken by noon, scattered by 1700, and dissipating by 2000 local.

(b) Showers and thunderstorms occurring with this situation are isolated to scattered, and typically occur during two periods. The nocturnal showers that form over the adjacent ocean area may move onshore between 0900 and 1100 local, and the afternoon showers will form between 1500 and 2000 local.

c. Fronts:

(1) <u>Type 1 - Cold Front approaching Jacksonville, northwest winds behind the front:</u> This type of frontal passage is rare during the summer due to the dominance of the Bermuda

high. Some years one passage may occur during late May or early June. September will usually experience one of these frontal systems and as mid-October approaches, the frequency increases. For the remainder of the summer these fronts dissipate by the time they reach Jacksonville or remain well to the northwest, assuming an east-west orientation.

(a) However, when the front does approach, pre-frontal conditions will consist of broken middle and high clouds gradually lowering at the front to ceilings of 600-800 feet with multiple layers to an overcast at 8000 to 10000 feet.

(b) Scattered showers and thunderstorms will usually occur with frontal passage.

(c) The sky becomes broken behind the front and normally clears within 6 to 9 hours after passage.

(d) When the front dissipates prior to arriving in the local area, only scattered middle clouds and broken high clouds will occur.

(e) When the system becomes stationary to the northwest, conditions are similar to those experienced under the subtropical ridge, except that afternoon thunderstorms are more intense with ceilings and visibility as low as 100 feet and 1/4 mile.

(2) Type 3 - Cold front approaching Jacksonville, northeast winds behind the front: Three distinct patterns exist with this frontal system (Figure 38 and 39) in summer.

(a) The first and most frequent pattern finds the front well to the north of Jacksonville. It occasionally advances as far south Charleston and Savannah, where it dissipates or moves back north. When the front stays to the north, Jacksonville remains under the dominance of the subtropical high.

(b) In second pattern, which occurs only about once or twice during the summer, the front moving south of Savannah and becomes stationary over Jacksonville, where it gradually dissipates. When it becomes stationary nearby, weather during the day is typical, except that stratus and fog lower ceilings and visibilities zero to 500 feet and 1/4 to 3/4 mile between 0600 and 0900 local.

(c) With the third pattern the front passes Jacksonville, becoming stationary a short distance south of or over central Florida, where it dissipates or moves back as a warm front. This situation occurs about twice during the summer.

When the front becomes stationary a short distance south of Jacksonville, early morning ceilings and visibilities are 400 to 800 feet and 3 to 5 miles in light rain, drizzle and fog, lifting to 600 to 1000 feet by noon and 1000 to 1500 feet by late afternoon. These conditions will continue until the front moves to central Florida or dissipates.

d. Unusual Situations, Easterly Waves:

(1) Easterly Waves (Figure 49): Most easterly waves pass to the south of Jacksonville, but a few times each summer a well defined easterly wave will extend into the local area. It is difficult to accurately determine the axis of the wave as it approaches northern Florida from the southeast. One indication will be the orientation of the Bermuda high. A cyclonic depression or trough can be detected as it moves westward along the southern side of the high at a speed less than the surface wind. This phenomena should not pass through the islands southeast of Jacksonville undetected.

(2) Another clue to the existence of an easterly wave is in the analysis of the upper winds. The upper winds frequently show a more pronounced trough than at the surface.

(3) At Jacksonville, increasing middle and high clouds will gradually be accompanied by low cumulus and showers, which will last from 1 to 2 days. Northeasterly winds in the western part of the wave will shift to easterly and southeasterly as the trough approaches and passes.

**G. Fall Synoptic Climatology (Mid-October through late November)**

a. The continental high begins to push farther south and covers a larger area. Generally, these highs will move across the country on the zonal track through West Virginia, however a secondary track lying farther south becomes evident during November.

(1) At Jacksonville, it will generally be clear at night with scattered cumulus during the afternoon. Visibility will be unrestricted as long as the winds are northwest or north.

(2) When the high becomes stationary along the coast of the Carolinas the circulation around the high pressure is predominantly over water. Modification of the high occurs similar to the situation during a northeaster. Ceilings and visibility can rapidly deteriorate in fog, haze, and smoke (see Special Features section).

b. The Subtropical High shifts further east, and appears for only a few days during this season. It influences north Florida very little by mid-November. When it does, conditions are very similar to summer.

(1) Since the air mass is warm and moist, broken to overcast middle and high clouds occur during the day. Scattered cumulus forms near 1000 local time and is occasionally broken between 1100 and 1500 local. These low clouds dissipate by 1700 local, leaving only the high clouds. Visibility is the major problem with this system. During the middle of the day the visibility is unrestricted.

(2) In late afternoon, a low level radiation inversion forms and smoke from local industrial areas and/or forest fires is trapped. Since there is no mixing, visibility is reduced to 2 to 5 miles.

(3) Advection fog will affect NAS Jacksonville most nights under this situation, lowering visibility to occasionally zero between 0300 and 0700, gradually lifting and becoming unrestricted by noon.

c. Fronts:

(1) <u>Type 1 - Cold front approaching Jacksonville, northwest winds behind the front (Figure 35):</u> The continental high moves south to the vicinity of Texas before swinging eastward toward the Atlantic. As fall progresses, this type of front passes more frequently. October will usually have one or two of these fronts. November normally has at least two or three.

(a) At Jacksonville, many of these fronts will pass with clear skies and good visibility.

(b) If the air mass is warm and moist ahead of the front, multiple cloud decks will form, with rainshower and occasional thunderstorms.

(c) Post frontal conditions with the dry air intrusion normally consist of reduced visibilities in nocturnal radiation fog. Between midnight and 0800 local time, the visibility will range from 1 to 4 miles, gradually improving and becoming unrestricted by 1000 local time.

(d) With the second condition, post frontal clearing is usually slow and requires about 9 hours for clearing.

(e) Nocturnal radiation fog is also evident with this situation.

(2) <u>Type 2 - Cold front preceded by squall line:</u> This system (Figure 37) rarely appears during the fall months. When it does, the synoptic features and conditions are similar to the winter and spring patterns.

(3) <u>Type 3 - Cold front approaching, northeast winds behind the front:</u> During the fall months, this system (Figure 38) occurs with almost equal frequency as the Type 1 cold front. The synoptic pattern is similar to other seasons of the year, i.e. the continental high is on a zonal track across the country well north of Jacksonville. Local weather will be the same as the winter season.

(4) <u>Type 4 - Warm front developing southwest of Jacksonville (Figure 40):</u> These become more frequent as November progresses. The synoptic pattern for formation are similar to spring. The polar front moves through the local area, becomes stationary to the south, and then moves back over the station as a warm front within 1 to 2 days. At Jacksonville, weather will be similar to the spring situation.

(5) Type 6 - Gulf Waves: They make their appearance in late October and by mid-November are a regular feature of the surface map. Synoptic features are identical with the winter situation (Figure 41). At Jacksonville, gulf waves cause the same weather as in winter.

(6) Type 7 - Atlantic wave forming east of Jacksonville: As with the gulf wave, this system becomes more frequent during November. Normally, they form further offshore (Figure 43). Local weather will be similar to the winter situation but higher ceilings and less chance of precipitation prevail.

## H. Special Features

1. Tropical Cyclones:

(1) The intensity of tropical systems vary greatly, from the category 5 hurricane, with sustained winds over 135 knots, to the tropical disturbance. The following classifications are used in the Atlantic region:

(a) Tropical Disturbance - circulation slight or absent on the surface, possibly more evident aloft, but no closed surface isobars.

(b) Tropical Depression - one or more closed surface isobars. Sustained winds less than 34 knots.

(c) Tropical Storm - closed isobars, sustained winds greater than 33 knots, but less than 64 knots.

(d) Hurricane - sustained winds of 64 knots or more. Although Jacksonville is in the "Hurricane Belt" (See

Figures 50 through 59), it receives the full force of hurricanes very rarely. During the period 1886-1994, 66 named tropical cyclones passed within 100 miles of Jacksonville. It is noteworthy that during the period 1886-1994, only one fully developed hurricane made landfall at Jacksonville directly. That one was Hurricane DORA in 1964. In comparison with the rest of Florida, the Jacksonville area is relatively storm free. The rarity of hurricane occurrence in Jacksonville can be attributed to the following:

(2) A tropical cyclone will decrease in intensity when deprived of the warm water which is its primary source of energy. Over 70% of the tropical cyclones passing within 100 miles of Jacksonville traveled over land before reaching Jacksonville.

(3) Many of the tropical cyclones that pass to the east of Jacksonville follow the warmer waters of the Gulf Stream, which tends to keep them off shore.

2. Tornadoes:

Tornadoes have accompanied nearly all tropical cyclones that have approached Florida. In every case they have occurred in the outer feeder bands of the hurricane circulation and not near the central vortex. They have a tendency to occur on the advancing edge of hurricanes moving northward and on the right edge of those moving westward. Most tornadoes associated with hurricanes observed in Florida have been narrow in width and have had rather short paths, but they have been very destructive.

3. Sea Breeze: NAS Jacksonville is located 14 miles inland from the Atlantic Ocean. Surface temperature gradient between land and sea are caused by daytime heating, producing a diurnal low pressure area over the land. This will occur,

especially during the summer period, with relatively clear skies and calm winds. A resultant onshore wind from the east, gradually veering southeast occurs by late morning. Arrival time and strength of the sea breeze will depend on the sky conditions and the gradient wind.

(1) Ideal conditions for early occurrences will be clear skies and calm winds or a gradient wind from the east quadrant. Under these conditions, local effects from the sea breeze can be expected to begin between 1000 and 1200 local. Under less favorable conditions the sea breeze may not develop until late afternoon. With ideal conditions the sea breeze may progress as much as 30 to 40 miles inland and extend vertically to 2500 feet. Strongest effects will be found at the coast and within the lower 500 feet. The speed of the average sea breeze is 10 knots.

(2) With the arrival of the sea breeze two effects in the local weather may be noted.

(a) The first will be a decided drop in temperature or a halt to the diurnal rise that otherwise might be expected. The total effects on the local maximum temperature due to the sea breeze, or lack of it, may amount to between $10^{\circ}$ to $12^{\circ}F$.

(b) The second effect may be the development of thundershowers along the Florida coastline and up to 30 miles inland. The cooler, stable, air from the ocean acts as a lifting mechanism due to the sea breeze and may provide a trigger for the development of these thundershowers.

4. Northeast Stratus:

(1) Stratus at Jacksonville is referred to as northeast stratus since it forms almost entirely with surface

winds from a northeast direction. It's development is dependent on a large offshore sea surface temperature gradient, and with a few exceptions only forms during the months of November through March.

(2) The same variables which produce fog are important in the formation of stratus. Analysis suggests that most stratus forms in the Jacksonville area with a synoptic situation similar to that which produces pre-frontal and post-frontal fog. Climatology indicates that fog formation almost always occurs with 1000 foot winds of less than 15-20 knots. Stratus may also result from sea fog being advected onto a slightly warmer land surface, or by daytime heating of the land surface, resulting in evaporation of the lowest level of fog layers.

(3) Northeast stratus will usually occur a day or so following a cold frontal passage. It will form when the following continental high brings northeast wind to a height of at least 2000 feet. In this case, the center of the high pressure system is usually north of Norfolk, VA and east of Pittsburgh, PA, with Jacksonville located in the southeast quadrant.

(a) The onshore flow from this situation will produce widespread stratus clouds. Ceilings will vary from 600 to 1200 feet in mid-afternoon, but may be expected to lower from 0 to 300 feet after midnight, depending on the wind, temperature, and dewpoint relationship. Cloud tops will range from 2000 to 3000 feet. Visibility under the stratus is usually good during the day.

(b) Dissipation may occur with the movement of the high pressure system or weakening of the gradient. The northeast stratus occurs on an average of 8 times per year, usually persists from 1 to 3 days, but may last for 7 days.

5. Smoke and Haze.

There are two periods of the year when smoke and haze are most hazardous to local flying:

(1) The first is a forest fire which can occur primarily during the later part of October through November.

(a) Usually the smoky period occurs with a high pressure cell over the eastern states. An inversion in the lower levels traps the smoke thereby reducing low level visibility.

(b) Surface visibility may vary from 1 to 6 miles, better during the afternoon, decreasing at night as cooling takes place. The vertical extent of the smoke layer may be from the surface to 6000 feet. It is sometimes thick enough to constitute a ceiling and is especially hazardous to flight level slant range visibility.

(c) The smoke hazard may be ended by a wind shift, or by increased mixing and turbulence in the atmosphere which destroys the inversion.

(2) The second type of smoke and haze problem occurs in winter. A high pressure cell extends over Jacksonville. Again, a temperature inversion traps the smoke.

(a) Light north to northeast wind brings in smoke from industrial and residential areas from the north. This is especially noticeable when the winds bring the smoke from the two large paper mills just north of Jacksonville.

(b) From 0600 to 0800 local, as a result of nocturnal cooling and subsidence, the smoke begins to restrict visibility to 2 to 5 miles and occasionally lower. With a thicker smoke layer or sharper inversion over the station, this may occur before midnight. The smoke layer will usually extend to 500 feet.

(c) Smoke will persist until the wind shifts to the east or northeast. Such a shift, even with winds only 3 to 5 knots, will usually increase the visibility to VFR conditions within 30 to 45 minutes. It may also occur through diurnal heating and mixing of the atmosphere which destroys the shallow inversion. In any event, VFR conditions are usually present by 0930 to 1030 local time.

6. Thunderstorms:

(1) Air Mass Thunderstorms - due to the Tropical Maritime air mass which is nearly always present in the summer, the elements necessary for thunderstorm formation are usually found. During the winter, when Maritime Tropical air invades the eastern section of the United States, it is cooled from below. This cooling increases the stability in the lowest layer of the atmosphere. During the summer months continental heating steepens the lapse rate and in combination with sufficient moisture, conditional instability results. This combination will cause showers, thunderstorms, and an occasional tornado.

(a) Convective. The most common cause of thunderstorms in Florida is convection from surface heating in conjunction with convergence caused by the sea breeze from both coasts. This can easily be seen by studying Figure 60. Convection is the primary cause from April through October.

(b) Nocturnal. Radiational cooling of cloud tops leads to instability as the cool air sinks, displacing the warmer air below. Thunderstorms attributed to this cause will occur at night, and generally over the ocean. If wind conditions are right these storms can move over land.

(c) Convergence. Florida is affected by a more or less permanent zone of large-scale horizontal convergence. Simultaneous sea breezes move onto the peninsula from both the Atlantic Ocean and the Gulf of Mexico. Such a two-sided sea breeze is peculiar to this type of land mass and, as would be expected, reaches its peak at a season and time of day corresponding closely with the Florida thunderstorm maximum (Figure 60). When the gradient winds are light and no other source of convergence is present, sea breeze convergence at low levels begins about 4 hours after sunrise and slowly increases in intensity throughout the day. A maximum is reached at approximately 1700 local with a rapid decrease thereafter until divergence is noted at 1,000 feet after midnight as a land breeze develops. Troughs are likely areas of convergence, and once or twice a year an upper zone of convergence will move across in the easterlies causing extended periods of heavy precipitation. It is possible to detect these zones and make an appropriate forecast, but only by a systematic, careful study of the upper air flow.

(2) Frontal Thunderstorms: Frontal thunderstorms are classified according to the type of front with which they are associated. In each case, the characteristics of the warm (over-riding) air mass will determine whether thunderstorms will or will not accompany the front. In this connection, the speed of advance of the front is also a contributory factor.

(a) Cold Frontal. During the winter, Polar Fronts will normally pass through Jacksonville about once every 5 to 6 days. If the warm air mass is sufficiently unstable and moist, thundershowers will occur. The most common of these are the pre-frontal variety. This is particularly true of the situation where the warm air mass is very unstable and moist and the cold front is fast moving. In these cases, the front will usually pass with little or no cumulus activity.

(b) Prefrontal. Prefrontal thunderstorms occur in the warm air mass preceding a cold front. They may be scattered or appear as a squall or instability line. With the typical prefrontal conditions, winds aloft are south to southwest. All authorities agree that a warm sector is the ideal place for squall line formation and should be looked upon as an area of suspicion. However, this is not necessarily the only place of formation. It is not uncommon to find a squall line north of a warm front.

(c) Warm Frontal. Warm frontal thunderstorms are fairly common in this area as the polar front moves back and forth across Jacksonville while it is quasi-stationary between major outbreaks of cold air. The important fact is that the warm air mass must be unstable enough so that the gentle lifting over a warm frontal surface is sufficient to cause cumulonimbus clouds to develop.

(d) Stationary Frontal. Thunderstorms along a stationary front are fairly common in the Jacksonville area. When the quasi-stationary Polar Front lies across the southeastern United States as far south as southern Florida, as it does many times each year, a dangerous thunderstorm situation may exist. Along that portion which is stationary, thunderstorms rarely develop. However, with an unstable warm air mass, they may line up along this frontal surface. When perturbations form along this frontal surface, we may in one day experience in succession warm frontal, prefrontal, and cold frontal thunderstorms in any order. Again, the determining factor will be the stability and moisture content of the warm air mass.

(3) Characteristics of Thunderstorms in Florida:

(a) Precipitation. A single thunderstorm may produce as much as 3 or more inches of rain in an hour, which can cause damage by flash floods.

(b) Hail. Hail associated with thunderstorms may cause a great deal of damage. Hail greater than 1/4 inch in diameter is a serious threat to aircraft, property and lives, if there is no warning. The diurnal distribution of hailstones (3/4 inch diameter or larger) indicates a concentrated maximum in the three-hour period from 1500 to 1800 local.

(c) Surface Winds. Surface winds in a thunderstorm will usually peak at 28 to 40 knots, however, they may gust considerably higher. Many steps can be taken to prevent property damage and personal injury if a timely warning is given.

(d) Turbulence. Severe turbulence should be expected in a thunderstorm, particularly in the mature stage. Every possible plan should be considered and offered to the pilot during briefings, especially that which offers the best chance for staying out of the thunderstorm at any given altitude.

(e) Thunder and Lightning. Thunder is a mental hazard only, while lightning is a real fire and electrical hazard. Considerable damage is done each year in Florida by forest fires set by lightning, lightning strikes to homes and power surges damaging electronic equipment. At least 10 people are killed each year in Florida by lightning and many more are injured.

(f) Spearhead Echo and Downburst Cells. Due to recently improved observation equipment (satellite, and more numerous weather radar installations) as well as new observation techniques, previously undocumented phenomena called "Spearhead Echo" and "Downburst Cell" have been identified and analyzed. Weather associated with these phenomena has been severe in all case studies thus far. "Spearhead Echo" is a pointed appendage appearing ahead of a layer cluster or line of thunderstorm cells on the radar. Ground based weather radar may be able to detect a spearhead echo 100 miles away. The appendage moves much faster than the parent echoes which are being absorbed by the rapidly intensifying spearhead. During the mature stage of the thunderstorm the appendage will have grown into a major echo with the parent cells losing identity. Hidden within the spearhead echo will be from one to several thunderstorm cells with intense downdrafts called "downburst cells". At the present time there are no means of predicting the occurrence of these phenomena. However, awareness that they exist coupled with a radar spearhead echo, will enhance the ability to evaluate and suitably express the thunderstorm situation.

(g) Tornadoes. During the period 1950-1990 an average of 44 tornadoes have occurred per year. There were also 70 tornado-caused deaths. The greatest number of tornadoes per year occurred in the mid to late 70's. During 1975 new Florida records were established--February with 10, April with 13, August with 13 and September with 9 tornadoes. The average tornado path in the United States is about 200 yards wide and about 9 miles long. Rather meager data on tornadoes in Florida indicate an average path of about 125 yards wide and about four miles long. The spacial differences across Florida merits further study. Some of these differences might be due to the land-sea relationship and it's effect on the meteorological process. A second factor is that Florida's extensive coast line offers excellent opportunity for waterspouts to come ashore and be classified as tornadoes, which in fact they are, when accompanied by threatening clouds. However, waterspouts usually dissipate soon after reaching the shore line, hence affecting only a small area.

(4) Thunderstorm Statistical Data

(a) 0000L to 0600L. Slightly less than two occurrences at Jacksonville during summer quarter. Frequencies marked higher along the Gulf Coast.

(b) 0600L to 1200L. Frequencies in Jacksonville are about 11 per summer. Of interest is the increase in frequency along the coast lines as the activity begins to move inland with the transition from "warmer" water to "warmer" land. (Land breeze to sea breeze).

(c) 1200L to 1800L. The frequency quadruples from the morning category. (Note that the higher frequency occurs near Ocala, Florida, where the peninsula is the narrowest. This would seem to indicate that the activity is greatest at the inward limit of the sea breeze, and here we have maximum convergence as a result of both sea breezes). Frequency is 44, meaning that in this most active area in the United States, any point should statistically experience one thunderstorm every two days. With south to west-southwest "steering level" flow, these thunderstorms are carried to the Jacksonville area.

(d) 1800L to 0000L. Similar to 0600L except for absence of off-shore "high activity". Note also high frequency over central Georgia near the northwestern edge of Okefenokee Swamp in an area of many lakes and rivers (centered between Alma and Valdosta, Georgia).

7. Fog.

The occurrence of fog in the local area extends principally over a six-month period from October through March. During the remainder of the year any fog is usually light and the frequency is decidedly less.

(1) An air mass circulation which brings moist air from the Atlantic to Jacksonville from the northeast through the south-southeast is the main fog producing situation. This is especially true when the air flow has crossed the Gulf Stream before reaching Jacksonville. Clear skies and light surface winds, together with radiational cooling of this moist air mass, are the main factors in the fog formation. Fog resulting from other phenomena (e.g. radiation fog following convective precipitation) only rarely is sufficiently widespread, dense, or persistent enough to hamper local aviation.

(2) A second air flow pattern that brings fog to Jacksonville consists of air which has been advected from the Gulf of Mexico. Fog formation of this type will again be aided by clear skies and light winds. Fog from this situation is much less frequent than that formed with an Atlantic Ocean trajectory.

(3) Under favorable conditions fog in the local area will generally form between 0000 and 0600 local occasionally forming as early as 2100. Dissipation in the morning hours will occur between 0700 and 1100 local, depending on thickness of the fog layer, other cloud decks, and the wind conditions. A rough approximation for air mass fog dissipation is provided below. Visibility will range from zero to six miles. Dense fogs with visibilities of zero to 1/4 mile occur 25 to 35 days during the October-March season, with greatest frequency from November through February.

(4) The following guide may be used by the forecaster to aid in forecasting the dissipation of fog and stratus:

| THICKNESS OF LAYER IN FEET | TIME TO CLEAR IN HOURS |
|---|---|
| 500 | 1 |

| | |
|---|---|
| 900 | 2 |
| 1,200 | 3 |
| 1,500 | 4 |
| 1,900 | 5 |
| 2,200 | 6 |
| 2,600 | 7 |
| 3,100 | 8 |
| 3,500 | 9 |
| 3,900 | 10 |

## I. Local Climatology/Climatological summary.

A climatological summary of weather data at NAS Jacksonville since 1945 is provided in table 1 and is compiled both by month and year.

1. In the summary of flight conditions, VFR (Visual Flight Rules) refers to conditions with ceilings equal to or greater than 1,000 feet and visibilities greater than 3 miles.

2. Instrumental Flight Rules (IFR) refers to conditions with ceilings less than 1,000 feet or visibility less than 3 miles.

# SECTION III - LOCAL FORECASTING

## A. Subjective Rules

1. Advection/Radiation Fog

a. General.

1. Advection/radiation fog is formed in air brought to saturation by a more or less equal combination of radiative and advective processes.

2. In addition to advection and radiative cooling, humidity of the air is also important.

3. The probability of fog is greatly increased if:

(a) The wind is blowing from the Atlantic or Gulf of Mexico.

(b) The ground is wet.

(c) The air has recently been moistened by evaporation of falling precipitation.

(4) After the fog has formed, it normally dissipates by 1000 local the following morning due to the sun's heating. Of course if the fog layer is thick, or if a cloud deck moves in aloft, the fog persists longer. If the underlying ground is very wet, insolation causes evaporation and increases the dew point thereby delaying fog dissipation.

(5) To accurately forecast fog formation, the forecaster must determine:

(a) The horizontal distribution of winds and whether these winds will accelerate during the forecast period.

(b) Where fog occurred the night before.

(c) Types and extent of clouds.

(d) Horizontal distribution of temperature, dewpoint, and precipitation.

(e) A knowledge of local and regional climatology enables the forecaster to evaluate the long term odds favoring fog formation at a given time of the year, given certain synoptic features and local conditions.

(6) Evaporation results in a high relative humidity and dew point in the air moving over warm waters adjacent to the southeastern United States.

(a) In late summer and early fall, water temperatures are lower than that of the nearby land in the afternoon.

(b) The maritime air may be considered <u>relatively</u> cool, as well as moist.

(c) If this air moves inland (replacing the warm, dry land-air), it may be cooled to saturation by nocturnal radiation during the long autumn night resulting in formation of fog or low stratus.

(d) The synoptic situation related to this fog type is one which brings moist air inland and the night time cloud cover is minimum.

(e) In the southeastern United States this circulation may be provided by flow around the western side of the Bermuda High, or by the return flow from a Continental Polar High which has moved well out over the water.

b. Radiation Fog: To forecast strictly radiation fog at Jacksonville:

(1) Compare the dewpoint at afternoon maximum temperature to the temperature at sunset. If the spread is 6 to 10 degrees, forecast 1-3 miles in fog during early morning hours.

(2) The wind must be light and there must be sufficient moisture.

(3) Later afternoon or evening rain showers will raise the moisture content.

c. Advection Fog: Fog is advected to Jacksonville from the southwest or northeast to southeast.

(1) A southwest flow may advect moisture from either the Gulf of Mexico or the spotty marshlands southwest of Jacksonville.

(a) This flow is typically observed in winter months where there is a ridge extending across the Florida peninsula from a high centered in the western Atlantic.

(b) Monitor conditions at Tallahassee, Gainesville, Orlando and Cecil Field.

(c) Conditions are favorable for fog at Jacksonville if the dewpoint-temperature spread is 2-8 degrees at these stations during early evening hours and surface winds are light southwesterly or calm.

(2) Fog is advected from the northeast to southeast primarily during October and November.

(a) A high centered over the southwestern U. S. will produce the appropriate flow pattern.

(b) Fog is formed by moisture gathered from the warm Gulf Stream waters and condensed by the relatively cool water between northeast Florida and the Gulf Stream. This is a difficult phenomenon to forecast.

(c) PIREPS from the operating area and monitoring of conditions at Mayport may help.

(d) Southwesterly flow can result in WOXOF conditions at Jacksonville a short time after onset.

(e) Northeast flow will normally not advect fog over Jacksonville before 0400L.

2. Frontal Fog

a. Frontal fog occurs primarily during the winter months and is formed by evaporation of relatively warm rain as it falls through the cold air below.

b. Post-frontal fogs are less persistent than pre-frontal fogs.

c. Frequently, a southward moving cold front becomes quasi-stationary in which case the precipitation and fog patterns resemble those associated with a warm front.

(1) This is particularly true of stationary fronts with an east-west orientation across Florida.

(2) The maritime air from the Gulf may override and precipitate into Continental Polar air beneath for several days in a row.

(3) Precipitation is especially heavy with the passage of waves along the frontal surface.

d. Pre-frontal and post-frontal fogs are likely to form only when the synoptic situation indicates active overrunning or uplifting of warm, moist air over cold, stable air, resulting in continuous precipitation (Figure 61).

e. The time of onset of fog should be forecast as follows:

(1) November and March, 2100L.

(2) December and February 2000L.

(3) January, 1900L.

f. The time of breaking or lifting should be forecast as of 1000L the following morning regardless of time of onset, although many will clear and lift earlier and some later.

g. Figure 62 shows a typical case of early fog conditions. Note the extensive rain area, the weak gulf wave, the marked wedge from a typical high center, and the Great Lakes Low.

h. Figures 63 and 64 show superficially similar patterns which should not be allowed to confuse the forecaster. In these patterns, ceilings of 200 to 700 feet are the rule, and no dense fog should be forecast.

3. Gulf Lows

a. Shallow, unstable lows will occasionally form on a stationary front in the Gulf of Mexico.

(1) These may be observed in the gradient flow at 850 MB (occasionally higher) and by increasing clouds on satellite pictures.

(2) Minor troughs at 700 MB passing over the system may cause rapid deepening of the lows resulting in gale force winds which are difficult to predict in advance.

(3) Generally, systems that form in the western Gulf of Mexico will usually fully develop before crossing the Florida panhandle.

(4) Systems forming in the central through northeastern Gulf of Mexico will continue to deepen as they move between Jacksonville and Savannah, Georgia.

b. February and March have been observed as the most likely for the Gulf of Mexico systems.

(1) Lows will typically form when a winter/spring block forms over the northeastern Atlantic, and a strong ridge over the west coast retrogrades to the eastern Pacific developing a cut-off high.

(2) The major long wave positions itself over the southern plains (occasionally another cut-off high develops over Canada).

(a) In such a pattern the westerlies divide into two branches; one northward around this high with the other branch over a southern route and across the Atlantic.

(b) This situation produces a number of surface cyclones along the southern track, the majority of which develop in the western Gulf of Mexico.

c. Normally the surface progs do not depict precipitation far enough in advance of the Gulf of Mexico systems (the 300 mile rule does not hold).

(1) Light rain will often commence with the middle clouds, some 300-500 miles in advance of the warm front (700 mb ridge line).

(2) The ceiling will lower rapidly to stratus ceilings with moderate to heavy rain as the warm front moves closer.

4. Winter Inverted Troughs.

When a large high pressure cell is located off the Central East Coast of the U. S., an inverted trough between the areas of 75W and 80W may form. It produces low stratocumulus cloudiness within 50 miles inland from the coasts of North Florida, Georgia and sometimes South Carolina.

5. Winter-time Overrunning

a. On rare occasions, we experience a winter-time overrunning situation when a cold front passes Jacksonville with an east-west orientation.

(1) The front moves slowly southward through the Florida Peninsula and becomes quasi-stationary in central or south Florida.

(2) The cold high (1032 MB or higher) associated with this front moves from western Canada on a southeasterly trajectory and lies over Illinois.

(3) A broad 850 mb trough moves into position just off the east Texas coast, with an orientation such as to produce a warm moist southwesterly flow aloft over the southeastern United States (See Figure 65).

(4) As the cold front moves through Jacksonville:

(a) Winds become northeasterly 12 to 15 knots with occasional gusts to 20 knots.

(b) Multiple cloud layers with ceilings generally 8,000 to 10,000 feet with a lower scattered variable broken layer between 1200 and 1500 feet are experienced.

(c) Visibilities are generally 6 to 7 miles occasionally 5 miles in haze.

b. In order to forecast the deterioration of weather at NAS Jacksonville under this situation, the forecaster must be alert to the movement of the high pressure to the north.

(1) When this high moves to the east of the Appalachian Mountains; the surface winds over North and South Carolina, southeastern Georgia and northeastern Florida back rapidly to the north averaging 12-18 knots (see Figure 66).

(2) Within 1-2 hours of the wind shift temperatures will fall from 6-12 degrees F and the ceiling will lower to 300-600 feet.

(3) Visibility rapidly deteriorates to 1-3 miles in fog and intermittent light drizzle.

c. These conditions will persist over the local area until one of the following events takes place:

(1) The high pressure cell moves off the coast and east of 70W.

(2) 850 mb trough moves east of NAS Jacksonville.

6. Minimum Temperatures.

Winter time minimum temperatures at NAS Jacksonville are greatly affected by surface flow from the St. Johns River.

a. The water functions as a heat source during the night and surface winds from 310° to 190° will cause relatively warm air to be advected onto NAS.

b. This over-river flow can cause a 10-15 degree difference in minimum temperatures between NAS Jacksonville and NAS Cecil Field/Jacksonville International.

c. The coldest temperatures can be expected when a light (for maximum radiation cooling) surface wind from 245° to 310° occurs.

7. Smoke.

Smoke can affect the station at any time during the year. It may be caused by brush fires or advected to the station from the industrial areas and paper mills to the north. Forecast IFR visibilities due to smoke and haze between 0730 local when the following conditions exist together:

a. High pressure center in the local area.

b. Mostly clear skies

c. North to north-northeast winds less than 5 knots.

8. Haze.

Persistent haze which reduces visibility to 4 to 6 miles will occur with a subsidence inversion.

a. Light to moderate turbulence (moderate to severe for light aircraft) can be expected below the inversion with smooth conditions above. Turbulence will increase with surface wind speeds.

b. Forecast visibility 4 to 6 miles if all of the below occur:

(1) The local area is below the eastern edge of a high pressure ridge at upper levels.

(2) A surface high pressure cell dominates the weather over the area.

(3) A strong inversion exists between the 850 mb and the 500 mb level. NOTE: This inversion will normally be strong enough to cap off thunderstorm activity, but if surface heating does reach a critical value (94-97°F) strong thunderstorms can be expected.

9. General Thumb rules and Comments

a. When tropical lows pass close to the east of the local area, forecast clearing conditions when the winds back through northwest.

b. Generally, do not forecast convective thundershowers with easterly wind flow. Infrequent thundershowers that do develop from eastern quadrants are less intense than those developing south through west of the station.

c. Thunderstorms that do develop to the west and south will normally move east until they get to the river at which time they will turn north. These systems rarely cross the St. Johns River and reach the southside of Jacksonville.

d. Forecast early morning showers when the gradient wind is light easterly allowing early onset of the sea breeze which will bring inland nocturnal showers formed over the Gulf Stream.

e. Following the passage of a cold front which becomes stationary in the vicinity of Jacksonville, be alert for the passage of minor waves in the upper air which will cause a wave to form on the front. Under these conditions, forecast wave formation and passage with attendant weather conditions for the Jacksonville area.

f. Once a northward moving warm front reaches the central Alabama-Georgia area it is subject to rapid deceleration and will experience extreme difficulty in moving north of Atlanta, Georgia. It will push up the coast however at normal speed, unaffected by the mountains.

g. An old forecasting rule states: "Pressure rises far to the east of a strongly deepening cyclone." Conversely then, the building of a large upper ridge west of Jacksonville may indicate cyclogenisis in the local area.

h. Stationary fronts in the vicinity of Jacksonville will begin to move when the upper air changes from a high to a low zonal index or when a wave cyclone forms in the vicinity of Cape Hatteras.

i. Summer and Winter, forecast nocturnal land breeze with northwest winds less than 5 knots when a high pressure cell is in the general vicinity of Jacksonville and a very weak pressure gradient exists in the local area.

j. The wind direction is important for many forecasts at NAS Jacksonville. In some situations missing the wind direction will give you a bust for visibility, ceiling, weather, and temperature. Don't depend on the wind blowing parallel to the isobars as friction and local effects will often preclude this. There is one <u>case</u> where this is particularly true:

(1) When a wintertime cold front approaches Jacksonville from the west the closer its orientation to north-south, the greater the likelihood of rapid clearing following passage.

(2) The high pressure cell following the front will generally result in northwesterly winds over north Florida, even when the surface isobars indicate the winds should be from the north to northeast. The surface winds may cross the isobars by as much as 90° (Figure 67).

k. If there is only <u>one</u> high pressure cell associated with the system and it is located south of 35°N, the wind direction will be along a line direct from the high center to Jacksonville.

l. Should a front arrive with a nearly east-west orientation, there is a danger that the front will stall and become stationary partially down the Florida peninsula. This results in a northeasterly flow and low stratiform clouds with intermittent rain or drizzle over north Florida. These conditions may persist for three days or more (Figure 68).

m. When a deep trough or preferably a closed low appears on the 850mb, 700mb and 500mb levels, and is first observed in Louisiana, Jacksonville can expect steady light rain within 48 hours. If the trough or low is first observed further west, i.e., Texas, Oklahoma, or Colorado, and then moves into Louisiana, the precipitation will be thunderstorms and rain showers, rather than steady light rain.

## B. **Objective Rules and Techniques**

1. Thunderstorms

a. Summer Afternoon Thunderstorms (Technique A)

(1) Forecast air mass thunderstorms when the maximum temperature is expected to reach at least $84^{\circ}$-$86^{\circ}$F and high moisture at lower levels is expected. This is most often provided by the sea breeze which should reach NAS Jacksonville between 1100-1300 local.

(2) Forecast convective thunderstorms when the upper air sounding shows a steady high moisture content with 3.5 grams per kilogram at the freezing level.

b. Summer Afternoon Thunderstorms (Technique B)

(1) Forecast no thunderstorms if:

(a) Dew point at 0500 local is less than $60^{\circ}$F, with little increase expected, or

(b) (T-Td) 700mb + (T-Td) 600mb $> 28^{\circ}$C, or

(c) (T-Td) $\geq 13^{\circ}$C at any level from 850mb to 700mb

(d) T 850mb - T 500mb $< 21^{\circ}$C

(e) Mixing ratio at 700mb $< 3$ g/kg

A comparison of all five factors should be made in case of marginal criteria.

(2) Forecasting Air Mass Thunderstorms

(a) Time/Location - Prime areas of development are divided into groups by the time of day of most activity and wind flow (See Figure 69).

(1) 0000-0900 local - Over Gulf Stream and over inland bodies of water (12,000 ft wind NE-SE). Not expected past 1300 local.

(2) 0900-1300 local - Ten to forty miles inland along the coast and edges of inland water bodies (12,000 ft wind N-NE or SE-S). Not expected past 1700 local.

(3) 1200-1700 local - Over heated land areas of central Florida and southern Georgia (12,000 ft wind S-W-N). Not expected past 2100 local. These storms can be forecast to move in the direction of the 12,000 ft wind at about 80% of the wind speed.

(b) Coverage and character - The terms for thunderstorm coverage; isolated, widely scattered, scattered and numerous, are subjective and generally dependent upon the moisture distribution available and the triggering mechanism expected to effect the area. Generally airmass type thunderstorms will effect a greater geographical area at any given time but have less overall coverage than frontal or upper-air associated thunderstorms.

(c) Peak gusts - Table 2 is based solely on the 850mb and 500mb temperatures. It can be used to derive an approximate peak gust although moisture content, gradient wind and local factors are not taken into account. This table is designed for air mass thunderstorms during the months of April through October. It should verify reasonably well for air mass thunderstorms during the remainder of the year. If the 2-hour average wind plus 15 knots is higher than the computed peak gust from Table 2, that value should be used. The thunderstorm or shower must occur within 5 miles of the station to receive maximum predicted gusts.

(d) A quick method to determine the approximate peak gust is to add one knot for every thousand feet of vertical development to the speed of movement of the cell. This method is useful when a sounding is not readily available.

c. Forecasting Showers and Thunderstorms (Technique C)

(1) A good "Quick Look" at the stability of the airmass over the Jacksonville area is to retrieve the Skew-T analysis of the 1200Z Waycross sounding available over the NODDS system. This analysis is available by 1030 DST and is representative as long as Jacksonville and Waycross, GA are under a similar airmass.

(2) Technique C is a method that forecasts daily air mass convective activity using the 0000Z sounding which is expected to be representative later in the day of this area. It consists of a stepwise analysis of the sounding, arriving finally at an estimate of little or no convection, cumulus development, shower activity, thunderstorms or hail. Steps required for use of this technique:

(a) Plot the 0000Z sounding expected to be representative of this area later in the day.

(b) Determine the average relative humidity in the 1000-700 mb layer as greater or less than 50%. If the average relative humidity is less than 50% expect little or no cloud development.

(c) Adjust the lower portion of the sounding to destroy any surface radiation inversion present. Never choose a point higher than the first 75 mb of the sounding.

(d) Note the surface potential temperature of the sounding, then add 12° to it.

(e) Ascend dry adiabatically to the point of intersection with the sounding. Record the pressure in mb at the intersection.

(f) Subtract this pressure from the station pressure. The difference is called the DELTA PRESSURE.

(g) With the DELTA value and the humidity value go into the table to find the forecast.

(h) This technique is applicable in both summer and winter.

FORECAST TECHNIQUE

| DELTA PRESSURE | RELATIVE HUMIDITY | FORECAST |
|---|---|---|
| 200 mb or less | 50% or more | No convection |
| 200 but less than 250 mb | 50% or more | Mixture of cumulus and |

| | | |
|---|---|---|
| | | stratocumulus |
| 250 but less than 300 mb | 50% | Well developed cumulus |
| 300 but less than 350 mb | 50% | Cumulus clouds with good build-ups |
| 350 but less than 400 mb | 50% | Towering cumulus and showers |
| 400 but less than 450 mb | | Thundershowers and anvil tops |
| 450 mb and greater | | Thundershowers with hail and anvil tops |

d. The K Index. The K Index is a measure of thunderstorm potential based on the vertical temperature lapse rate, the moisture content of the lower atmosphere, and the vertical extent of the moist layer.

(1) The temperature difference between 850 and 500 mb is used to parameterize the vertical temperature lapse rate.

(2) The 850 mb dew point provides information on the moisture content of the lower atmosphere.

(3) The vertical extent of the moist layer is represented by the 700 mb dew point depression.

(4) The K-Index is computed as follows:

K = (850 temp - 500 temp) + (850 dew point) - (700 dew point depression)

(5) George found K values to be primarily applicable to the prediction of air-mass thunderstorms (i.e., those developing in areas of weak winds away from frontal or cyclonic influence).

(6) Values of K less than 20 generally resulted in no air-mass thunderstorms while values greater than 35 resulted in numerous thunderstorms.

e. The Showalter Index

(1) The Showalter Index is computed by:

(a) Taking the temperature at 850 mb and raising it dry adiabatically until it intersects the mixing ratio line which passes through the dew point temperature at 850 mb.

(b) From this point the air is lifted moist adiabatically to the 500 mb level.

(c) This temperature is then subtracted from the observed 500 mb temperature and this difference is the Showalter Index.

(2) When the index is below 0 (i.e., negative) thunderstorms may occur.

(3) Below -3 the index is said to indicate heavy thunderstorms.

(4) Below -6 is considered an indication that severe thunderstorms will occur.

(5) Indices above +3 are considered to be indicative of air masses unable to support thunderstorm activity.

2. Gulf Wave Cyclone.

Terminal weather at Jacksonville can be vastly different depending on the proximity of the wave center to Jacksonville and whether the center passes north or south. The following objective method was empirically developed as an aid to forecasters in determining the track of Gulf Wave Cyclones in a rapid, simple manner:

a. Mark the center of the surface wave cyclone on the 500 mb chart.

b. Determine the 500 mb wind direction over the wave cyclone and draw a vector equivalent to this direction from the center of the wave cyclone past Jacksonville.

c. Construct a perpendicular from Jacksonville to the vector just drawn.

d. Determine 500 mb wind direction over Jacksonville and note the difference this direction makes with the 500 mb wind direction over the wave cyclone (in degrees). If Jacksonville's 500 mb wind direction is greater (to the right or veering) than the 500 mb wind direction over the wave cyclone, assign a minus (-) sign to the difference.

e. Determine the 500 mb height over Jacksonville (in feet) and the 500 mb height over the intersection of the perpendicular from Jacksonville and the wind vector from the wave cyclone. Note the difference (in feet).

(1) If Jacksonville's height is greater, assign a plus (+) sign to the difference.

(2) If Jacksonville's height is lower, assign a minus (-) sign to the difference.

f. Convert the difference in wind direction to an empirical factor by placing a decimal point to extreme left of the number.

g. Convert the difference in height to an empirical factor by dividing by 10 and placing a decimal point to extreme left of the number.

h. Determine the algebraic difference (or sum) of the two factors.

(1) If the result is a plus (+) value, measure from the intersection of the perpendicular and wind vector toward Jacksonville a fractional distance equal to the factor. (If factor is 6.2, measure a distance which is 62% of the perpendicular).

(2) If the result is negative, measure from

Jacksonville along the perpendicular a fractional distance equal to the factor.

(3) Mark an X at this spot. Draw a vector from the center of the wave cyclone through this X. This gives the forecast track that the wave will take past Jacksonville.

i. Additional rules:

(1) If the 500 mb wind difference is zero and the height difference is also zero, forecast the wave to pass over Jacksonville.

(2) If the final factor arrived at is greater than .80 use only half of the factor value.

(3) For speed of movement, the old rule of using 50% of the 500 mb wind speed over the wave cyclone works satisfactorily.

(1) Position of wave cyclone is 25.3N 88.4W.

(2) Wind direction at 500 mb over wave cyclone is 210 degrees.

(3) Wind direction at 500 mb over Jacksonville is 240 degrees.

(4) Difference is 30 degrees. Since Jacksonville is greater, we add a + sign. Converting to a factor, we have +.30.

(5) Height of Jacksonville's 500 mb level is

5,780 meters or 18,963 feet. Height of intersection of perpendicular and wind vector is 5,740 meters or 18,832 feet. Difference is 131 feet. Since Jacksonville's height is greater, we add a + sign to the difference. Dividing by 10 and adding a decimal we arrive at + .131.

(6) The algebraic sum of the two differences is +.431. Since we have a plus value, we measure the fractional distance from the intersection of the perpendicular and the wind vector 43.1% of the length of this perpendicular. Mark an X at this point.

(7) Next draw a vector from the center of the wave cyclone through the X marked. This gives the track that the wave will take past Jacksonville.

(8) Since the 500 mb wind speed over the wave cyclone is 25 knots, the speed of movement forecast would be 12.5 knots.

k. This method was derived from examining all wave cyclones in the Gulf of Mexico in the period December-March for the years 1953 through 1955. It was tested on wave cyclones selected at random in the period December-March for the years 1956 and 1957. 22 wave cyclones were tested. 16 of those tested moved exactly as forecast by the foregoing method. The 6 that did not verify had errors of 5, 10, 20, 40, 60 and 76% although they did move across the perpendicular between Jacksonville and the wind vector from the wave cyclone. In all 6 cases, the wave cyclone moved closer to Jacksonville than forecast. The average length of the perpendicular in the 6 cases was 150 miles. Since the average error of the 6 misses was 35% we can assume an average error of only 52.5 miles 100% of the time.

3. Northeast Stratus

a. Often during the season from October to March, when a cold front has moved sufficiently south of the station for clearing to take place, a low stratus overcast will form and may persist for a period of one to three days.

(1) This overcast is usually below 1500 feet and persists only with a northeast wind.

(2) The stratus is usually confined to the coastal areas between Savannah and Daytona Beach, and extends inland 30 to 40 miles.

b. In addition to the northeast flow, which usually coincides with the southeastern portion of a high pressure cell, the moisture content in the lower layers plays an important part in stratus formation.

(1) The temperature - dewpoint differential is considered reliable enough to represent the moisture content for this purpose.

(a) To use Figure 71, a reasonably close watch should be maintained upon the movement of the high and its intensity.

(b) This will give a probable outlook for the stratus formation 12 to 36 hours in advance of formation.

(2) In 90% of all case studies by Watson (4), the high centers were located along the northeast coastal area of the United States and within an area bounded by ABC on chart number one.

(3) The position of the high pressure center when stratus forms depends greatly upon the intensity of the high pressure cell. The more intense highs were found to be displayed further to the northeast and usually within the area bounded by ADE on Figure 71.

c. In about 10% of all cases studied, stratus formed at Jacksonville when the high pressure center was located within the area bounded by FBG on Figure 71.

(1) In this situation there appeared to be no well defined high pressure center but more of a ridge oriented in a NE-SW direction so as to produce isobars which were mostly straight and oriented in a NE-SW direction in the Jacksonville area.

(2) In these cases the trajectory of the air over Jacksonville was about the same as that produced when the center of the high was north of the ABC area on Figure 71.

(a) The air mass had traveled for a considerable distance over a warm water surface, picking up sufficient moisture and heat to modify the cP air mass.

(b) This trajectory forms a limited mP air mass on the surface, extending to a depth of about 2,000 ft or higher.

(3) After contemplating the synoptic situation and after the required conditions in Figure 71 are nearing fulfillment:

(a) Enter Figure 72 with an actual or

forecast wind direction between NNE and ENE.

(b) Enter with wind velocity in knots as the abscissa and the forecast temperature - dewpoint differential as the ordinate.

(c) Figure 72 may be used to forecast the coverage and the height at which the stratus may expect to form.

(1) This chart should show a high percentage of accuracy for a period of 4 to 12 hours in advance depending mostly upon the ability and experience of the forecaster in forecasting the temperature- dewpoint differential and wind velocity for the period under consideration.

(2) A forecast for a broken to overcast condition should not be issued for any period when, on Figure 72 the coordinates are located to the left of the line ZZ.

4. East Coast Wedge Front.

When a front is oriented east-west crossing a line connecting Caribou, Maine with Cross City, Florida, and the surface isobars north of the front show an easterly component, it is designated an "East Coast Wedge Front." Forecast its movement with the following method:

a. Construct a line on the 850 mb chart connecting Caribou, Maine and Cross City, Florida (see Figure 73).

b. Note the latitude of the point where the surface front crosses the Caribou-Cross City line. This is the frontal reference point.

c. Measure the difference in height between a point 520 nautical miles to the west and the frontal reference point and correct this value for latitude by entering Table 3 and multiplying by the factor found. This corrected value is Z (west). (If the height increases to the west, the value is positive. If the height decreases to the west, the value is negative).

d. Measure the difference in height between a point 520 nautical miles to the east and the frontal reference point. Correct this value for latitude as in 3 above. The corrected value is Z (east)(If the height increases to the east, the value is negative.)

e. Measure the difference in temperature at 850 mb in degrees centigrade from the frontal reference point to a point 520 nautical miles to the northeast along the line connecting Caribou and Cross City. This value is T(850).

f. With the values from steps c and d enter Figure 74 for a preliminary prediction value.

g. With the value from Figure 74 and the T(850) obtained from step e enter Figure 75 for a final speed forecast of the front (24 hour period).

h. Move the frontal reference point south on the line connecting Caribou and Cross City. The following is an example using Figures 73-75:

(1) The frontal reference point = 33°N.

(2) The height of the reference point = 1540m. The height of the point 520 nautical miles west = 1542m. Z(west) = 1542 -1540 = 2m. The latitude of the point west is 35°N; the factor is .74. The corrected value =.74 X 2 = 1.48. The corrected Z(west) = +1.48. The height of the point 520 nautical miles east = 1549m. Z(east) = 1549 -1540 = 9m. The latitude of the point east is 31°N. The factor is .82. The corrected value of point east = .82 X 9 = 7.38. The corrected Z(east) = +7.38.

(3) The temperature at the frontal reference point is 11°C. The temperature at a point 520 nautical miles northeast along the line connecting Caribou and Cross City is 5°C. T(850) = 11° -5° = 6°C.

(4) Using Z(east) and Z(west), enter Figure 74 and extract the preliminary prediction value = 28 knots.

(5) Enter Figure 75 with the values obtained in (4) above and T(850) and obtain the final southerly movement of the front. In this instance, about 2 knots.

5. Frontal Forecasting (24 Hour Surface Prognosis).

This method is based on the theory that movements of surface features (front and air mass centers) are controlled by the flow of a given segment of the 500 mb chart above a particular feature, or portion of same. The mechanics of constructing such a surface prognostic chart are as follows: (See Figure 76)

a. Find the height difference a distance of thirteen (13) degrees latitude perpendicular across the mean 500 mb flow of a given surface position - frontal or air mass center.

b. Divide the difference by 3.

c. Using this difference, measured in degrees latitude, move the given position along the progged 500 mb flow for the ensuing 24 hour period.

d. Repeat these steps for as many positions along the front as is deemed necessary.

e. It must be emphasized that only the movement of pressure centers and frontal systems is forecast. Other established methods are utilized concurrently to forecast intensification or filling of the system.

f. Advantages of this method:

(1) Quick construction (10-15 minutes).

(2) Accuracy is very good east of the Rockies.

g. Disadvantages of this system:

(1) 500 mb prog must be good to excellent.

(2) Least reliable over and west of the Rockies.

(3) Not applicable near closed 500 millibar contours.

## C. **Applicable Reference Publications**

The following reference publications are available in the Operations Department technical library:

1. Weather Analysis in Tropical Regions.
2. Ballistic Wind and Density.
3. The Movement of Maritime Cyclones.
4. Applications of Meteorological Satellite High Resolution Infrared and Television Observations to Cyclogenesis Prediction.
5. Forecaster's Guide on Aircraft Icing.
6. Case Study of Severe Clear-air Turbulence.
7. Contrails Forecasting Manual.
8. Weather Briefing Manual.
9. Computation of Atmospheric Refractivity on the Skew T, Log "P" Diagram.
10. Compendium on Cirrus and Cirrus Forecasting.
11. Dynamic Meteorology Manual.
12. Defense Meteorological Satellite Program Users Guide.
13. Dynamic Meteorology for Aerographer's Mates.
14. Practical Methods of Weather Analysis and Prognoses.
15. Forecasting in Middle Latitudes.
16. The Use of Isogon-Isotach Charts for Determining Divergence, Relative Vorticity and Vertical Velocity.
17. Analysis and Prediction of the Depth of the Thermocline and Near-Surface Thermal Structure.
18. Storm-Surge Forecasting.
19. Oceanography for Navy Meteorologists.
20. Synoptic Analysis and Forecasting of Surface Currents.
21. Weather Analysis from Satellite Observations.

22. Operational Use of Weather Satellites.

23. On the Use of Radar in Identifying Tornadoes and Severe Thunderstorms.

24. On the Nature of Clear-Air Turbulence.

25. Surf Forecasting.

## SECTION IV - SPECIALIZED FORECASTS

A. A special forecast manual is available in the FDO bookcase at NAVLANTMETOCFAC Jacksonville. This publication contains detailed procedures for forecasting the following phenomena:

1. Sound Focusing
2. Contrails
3. Computing Refractive Index using the Skew "T"
4. Search and Rescue (SAR) Drift Calculations
5. Forecasting Sea and Swell
6. Computing and Forecasting "D" Values
7. Computing Nuclear Fallout

*NOTE: All of the above products are also available on TESS.

B. Additionally, the FDO has a list of the various SOP's which detail the actions required for issuing:

1. Severe weather warnings.
2. Freeze warnings.

3. Destructive weather warnings, and procedures to be followed when the following bulletins are received:

   a. National Weather Service Severe Weather Watch (WW)
   b. National Weather Service SIGMET's.
   c. National Weather Service AIRMET's
   d. National Weather Service and Navy Tropical Cyclone Warnings.

## SECTION V - ENVIRONMENTAL EFFECTS

A. When certain atmospheric conditions exist, the forecaster must be particularly alert to provide timely warnings/updates to supported activities that require unique consideration at NAS Jacksonville:

B. The following rules apply to unique requirements at NAS Jacksonville.

1. Thunderstorm Condition I - Lightning within 5 miles of NAS Jacksonville is a paramount safety consideration during aircraft refueling and weapons handling evolutions. Notify Base Ops.

2. Divert Field Operations - When operating carriers use NAS Jacksonville as a divert field for aircraft or shipboard emergencies, it is extremely important for the forecaster to amend the TAF with changing conditions and transmit the surface observations to the carrier, particularly when near field minimums.

3. Call the Tower when conditions become IFR/VFR as the observation is taken.

4. Small Craft Warning - Sustained winds in excess of 15 kts dictates issuance of a Small Craft Warning for NAVBASE Charleston, SUBASE Kings Bay and NAS Jacksonville.

5. Freeze Warnings - NAS Public Works requires advance warnings to maintain proper heating capacity and power availability. When the minimum temperature is forecast to be

30°F or below (for any period of time), or if freezing temperatures are expected to last for 4 hours or longer, a freeze warning will be issued prior to 1400 local time.

6. Wave heights of 12 feet or greater will adversely affect AXBT and Sonobuoy operations. Wave washover inundates the buoy/AXBT antenna which limits transmissions to the aircraft.

7. Temperature extremes and cross wind limitations affecting safe landing and take-off of the following aircraft types:

| ACFT | MAX | MIN |
|---|---|---|
| C12 | 52°C | -55°C |
| P3 | 53°C | No Min |
| C9 | 50°C | No Min |

8. The following crosswind Component Chart, Figure 77, may be used to determine both crosswind and headwind component on any runway.

Cross Wind Limitations

| | |
|---|---|
| C12 | 25 knots at 90° |
| P3 | 35 knots at 90° |
| C9 | 30 knots at 90° or 50 knot headwind |

9. The wind chill factor is the combined cooling effect of temperature and wind on exposed flesh. The Temperature - Humidity Index expresses the relationship between various combinations of temperature and humidity and produces an index of comfort or discomfort in humans. Wind chill factor Table

and TH Index, (Figures 78 and 79) may be used to determine the above criteria.

10. We occasionally receive requests from helicopters regarding "Special V" or "Special VFR." The nomenclature for "Special V" is a ceiling of 500 feet and the visibility at least one mile.

11. At the request of the Helicopter Community, we provide, hourly, pressure altitude and density altitude. A Density Altitude of positive 2800 feet or greater is operationally detrimental to the helicopters.

12. Figure 80, Atlantic Fleet Operating Area, Jacksonville, is provided so that you may become acquainted with the orientation of the primary JAX operating area.

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(1) COMMANDER, Naval Oceanography Command, ISMCS, 1945-92

(2) Elliot, R. D., "Weather Types of North America," Weatherwise, 6 Parts, Vol. 1-6, Feb.-Dec. 1949

(3) George, J. J., Weather Forecasting for Aeronautics

(4) Watson, J. D., Unpublished Paper; Forecasting Northeast Transitional Stratus at Jacksonville, Florida